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NAVAL POSTGRADUATE SCHOOL

Monterey, California



THESIS

A CONCEPTUAL LOGISTIC SYSTEM
FOR IRANIAN ENTERPRISE

by

Mahmoud Nourayi

June 1980

Thesis Advisor:

J. W. Creighton

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scientific advances in the management of a logistic system but who are not primarily concerned with the detailed mathematical basis of these advantages.

The final chapter presents a conceptual logistics system oriented toward Iranian enterprises.

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A Conceptual Logistic System For Iranian Enterprise

by

Mahmoud Nourayi
Commander, Iranian Navy

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
June 1980

ABSTRACT

This project is a survey of the business logistics system. The first part of the thesis describes the concept of logistics and identifies the fundamental logistics considerations and their characteristics for an effective and efficient logistics system.

This thesis is intended for those in or just entering the field of logistic systems who seek to understand and benefit from recent scientific advances in the management of a logistic system but who are not primarily concerned with the detailed mathematical basis of these advantages.

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I. INTRODUCTION

As far back as man can remember many of the goods he wanted were produced outside his immediate area. Foods and other commodities were produced in many places. Early man had limited choice. He had to obtain his requirements whenever they were available or move them to a storage area for later use. Because of transportation and storage facility constraints the movement of commodities was limited to those they could personally move and store. The time they could keep the goods was extremely short. These limitations and constraints forced them to live in areas close to production, and to consume a limited range of commodities. Today, for many people, these kind of problems do not exist any longer, however, there are still some countries where much of the population lives in small areas because they know the only way to obtain their requirements is to live close to the production area. Production efficiency and standards of living are usually low in this type of situation. One of the main reasons for these sorts of problems is lack of a well developed and inexpensive logistics system to facilitate an exchange of goods and resources not only with other producing areas of the country itself, but also with the other producing and consuming countries.

In many countries where logistic systems are improved the consumption and production points are separated geographically. Production companies are not looking for the most populated area and consumers are not willing to live close to the production activities. Areas specialize in those commodities which can be produced most efficiently. Production can economically be shipped to market areas where and when they are needed and in quantities desired. Extra needed goods can be imported and excess production can be exported. Today, logistic activities are critical to the individual firm, market areas are national even international in scope but production may be limited to several points. Logistic systems provide the "bridge" between the production activities and market that generally are separated from each other.

In many countries the concept of the logistic system and its role in any kind of organization has come to be generally recognized. Both business and government management are now beginning to accept the importance of the system and accept that the logistics system must be designed and managed as an important unit of the organization. Further, the author believes achievement of any organization's goals without having a relatively activated logistic system is really impossible.

A. PURPOSE OF THE THESIS

The focus of this thesis is on Iran, where understanding

of many logistics concepts are not well understood. Its purpose is primarily to introduce logistics concepts in concise form so that they will be easily accepted by the people in Iran or in other countries which have not yet needed sophisticated systems. The intent is to provide a survey of the elements of logistics systems so that the reader will have an appreciation of logistic system design, and will then be able to refine his design needs by referring to authorities providing greater detail. The secondary purpose is to propose a conceptual logistics system that can present logistics structure, logistics functions, and responsibilities in the Iranian enterprise.

B. SCOPE OF THE THESIS

The thesis is divided into three sections. The first section covers the basic areas and concepts of logistic considerations. The second describes characteristics of an effective and efficient logistic system such as: static principles of a good organization, basic functions of logistics organizations, forms of logistics organizations and Logistic Information Systems (LIS). The last section contains a proposed conceptual logistic system for logistics management based on characteristics of the Iranian enterprise.

The proposed logistics system is not a set of universal solutions and may not be appropriate to many different kinds of enterprise or business organization. Hopefully, the

proposed system can provide a way of thinking that eventually will help the reader recognize the logistics structure, logistics functions and scope of the logistics organization within the enterprise. Obviously, appropriate changes and modifications must be applied to the proposed system for any individual enterprise.

II. FUNDAMENTAL LOGISTICS CONSIDERATIONS

The concept of the logistic system and technology of logistics have made substantial advances in the decades since World War II. Today logistics is a word that sounds scientific. The purpose of this chapter is to provide a comprehensive and up-to-date review of logistics systems design and management. It is intended to discuss factors that must be considered, and introduce certain principles that may be useful guides to management. It is also intended to provide a background from which every newcomer in a logistics area can build a sound understanding of logistics.

A. HISTORY OF LOGISTICS

The word logistics is derived from two root words of similar sound but different meaning. It comes from the ancient Greek word "logistickos," that means, the art of calculation which the Greeks differentiated from the arithmetic of numbers. It also comes from a Germanic word "laub," meaning the leaves of trees and which came to mean an open shelter. The word "laub" then was changed to "loggia" in Italian and to "logistique" in French [23].

No one really knows when it was first recognized that business firms had logistics problems. Some authors believe 1880 was the first recognition of what is now called Business

Logistics. Others point to discussions of physical distribution in the 1920's as the early recognition. The fact is, logistics activities have never been separated from human life. In each century it has been perceived and treated differently.

Even in the earliest times man was involved with logistics activities, namely: determination of requirements, procurement, production, packaging and transportation. He recognized that he needed something to eat, something to protect himself with and somewhere appropriate to sleep (determination of requirements). He had to search and find adequate foods to survive (procurement). He had to make tools for protection and he had to prepare a proper place to sleep (production). Anytime he wanted to change his location he gathered his property (packaging) and moved them personally to the new location (transportation). So, unconsciously, man has been involved in logistics activities even from the earliest time. However, expectations from logistics systems today are quite different. Logistics today is a very broad science; so broad, that it is impossible to cover all its aspects and features in one chapter or even a book. Irrespective of when logistics began, the study of business logistics as a separate subject was not undertaken until relatively recently [8]. After World War II interest in logistics developed. During the industrial development in the United States of America, many large corporations were formed and attention was turned to

financial practices. As a result of corporations being large, markets could not regularly absorb the increased output, so the marketing area received attention. During this period the firms recognized that it was becoming increasingly difficult to keep the flow of products efficiently moving from the end of the manufacturing line to the consumer, so they recognized and perceived the distribution system. The growth and change in production lines increased the output so that distribution systems had more items to handle. Firms then decided to store the excess commodities. All the above factors and their related cost brought the areas of the logistics to the attention of many firms and pointed out the need of reducing such cost and introducing more effective controls. Today many firms in most countries recognize logistics as an area of management interest that can analyze the elements of logistics for possible changes resulting in lower cost [7].

B. SCOPE OF LOGISTICS

The military (as with so many other management concepts) provides a likely origin of the term "logistics." Logistics is defined in Webster's dictionary as, "moving, supplying and quartering troops." Logistics activities, whether they take place in military, in urban transportation systems, in government supply systems, in business, or in communication, are essentially the same. They usually involve procurement, storage and movement but with different aspects and for

achievement of different objectives. Ballou has defined business logistics as:

Planning, organizing and controlling of all moves - store activities that facilitate product flow from the point of raw material acquisition to the point of final consumption. And of the attendant information flows, for the purpose of providing a sufficient level of customer service consistent with the costs incurred for overcoming the resistance of time and space in providing the service [1].

Logistics in general and in the broad sense is concerned with the flow of material, people, money and associated information. Magee, another author, defines logistics as:

The art of managing the flow of materials and products from sources to user [25].

There are many other definitions for business logistics. What is common in all of these definitions is that logistics is concerned with physical supply and physical distribution. The author believes logistics is general notation of the total area of interest, knowledge and activities concerned with the planning, organizing, coordinating, controlling and the actual furnishing of support for people, equipment and operation.

C. LOGISTICS AND ENTERPRISE

Logistics in the military is one of the three major functions (tactics, strategies and logistics) that generally support the combat forces in such a way that they can carry on their missions. All human effort and facilitating resources are directed toward the objective of combat readiness. In business the concept is adapted to meet somewhat different

needs. Logistics, as a function of business enterprise, devotes its attention primarily to the movement and storage of raw material from supplier to plants and storage and movement of finished goods from plants to market or ultimate consumers. In military some demands have special priorities (top priority). In business all demands usually are considered "top priority" because of competitive markets. In short, logistics in enterprise refers to management of all activities which facilitate product movement and the coordination of supply and demand in the specific period of time and desired place.

D. LOGISTICS AND ECONOMY

Economics have defined in different ways by different people. On the the modern definitions of economics, given by Spencer Milton, indicates:

economics is a social science concerned chiefly with the way society chooses to employ its limited resources, which have alternative uses, to produce goods and services for present and future consumption [35].

Regarding the above definition, the question is, how logistics affect the economy and to what extent does logistics serve the economy? Logistics serves the economy in many different ways. Its significance is far greater than one might imagine. Logistics performs one of its roles by transferring excess commodities (resources) from points of surplus to points where more demand exists. Logistics extends the market area. Thus it adds economic value to the goods. Logistics also provides

goods and services at the right point when they are demanded so it increases the economic value of the goods by providing them at the right time and in the proper quantity. Logistics enables the firms to utilize their scarce resources more efficiently and more economically. In addition to the above factors, logistics provides a variety of jobs for employment in the United States of America. More than 13.2 percent of the total labor force are employed in logistics functions. Investment in privately owned transportation and logistics facilities has been estimated at over 200 billion dollars. Another interesting item is the estimate that more than 19 percent of the U.S. expenditures for goods and services, directly or indirectly, goes for logistics related expenditures. All these facts indicate that logistics plays a very important role in the economy. To provide goods and services in the right place, at the appropriate time and in the desired quantities, not only affects the individual firm but is important to the economy as well [7].

E. STRUCTURE OF LOGISTICS

In general the idea of structure is simple. Any building has structure, in the form of beams, interior walls, rooms, passageways and so on. The number of people, the type of equipment and its operation that will be located in the building are major elements that determine the structure of the building. On the other hand, the structure of the building should be so designed that people can utilize the defined equipment and perform their activities. Obviously, buildings designed for different purposes do not have common structure. Structure of an office building is quite different from that of a factory. The analogy of logistics structures to those of buildings is not proper because logistics structures are not built by architects but by the people within them. However, the factors that determine the structure of the building similarly affect the structure of the logistics organization.

Any organization structure serves two major functions. First it minimizes or at least moderates the influence of different individuals on the organization. The second is the establishment of the setting in which power is exercised, in which decisions are made and in which the organization functions are carried out [22]. Logistics structure facilitates the creation, the implementation and the evaluation of the plans. It is a formal mechanism that allocates men, material, services and facilities of the firm in order to provide the

best alternative that eventually contributes maximum benefit to the firm.

The chosen form of the logistics structure depends on the type of firm, the importance of logistics services to the firm, environment, resources and the kind of technology that is involved. Since logistics is primarily concerned with controlling the flow of materials and products, the development of an effective logistics structure is necessary. In fact, if these responsibilities are divided and assigned to different departments, the question arises as to how these activities are going to be coordinated in order to provide good customer service and to prevent out-of-stock cost.

In general, before any decisions are made about logistics structure the following factors must be evaluated by a group of qualified people and management. Is the company's logistics activities important enough to justify formal recognition as a separate entity with the firm? What activities should be included or excluded from logistics functions? What will be the relationship of logistics activity to other elements of the firm? When the answers to these questions are precisely cleared, the appropriate logistics structure can be defined. In any case, the logistics organization should be structured in such a way that by application of available materials, men, services and facilities, the elements of logistics can be planned, implemented and controlled according to the firms requirements.

F. ELEMENTS OF LOGISTICS

There are several basic elements in the logistics system of a business firm. A modern business firm is essentially an open system. It receives input from external sources, uses and processes this input and finally produces an output that to some extent changes the environment. A logistics system, as a subsystem of the business enterprise, handles the flow of input toward the process and also handles the flow of output toward the customer according to plan and with minimum cost. Business logistics as a system operates according to some basic elements. However, these elements have been defined differently by different authors. The intent here is to indicate those actual factors that make up a logistics system. These factors that also have been indicated by many authors are composed of forecasting that eventually determines the firm's overall requirement, procurement, storage, transportation, material handling, packaging and customer service.

1. Forecasting

Forecasting is a general term referring to those activities that generate a statement concerning uncertain or unknown events that will be occurring in the future. The main objective of making forecasts is to gain some knowledge about uncertain events in the future that obviously are important to present decision-making. A forecast is useful if it reduces the uncertainty surrounding an event. In other words, the cost of

a forecast system should not exceed the extra profit that is gained because of applying forecasts in decision-making. The value of a forecast does not necessarily lie in whether or not it comes true, but in its utility in leading decision-makers to choose a satisfactory course of action and to do it in time so that in the result of implementing that course of action creates payoff to the whole system. Forecasting is a prerequisite to planning and planning should be a prerequisite to action. It cannot be denied that planning is directed toward improving decisions. Forecasting in its dictionary sense means:

to anticipate or predict some future event or condition usually as the result of rational study and analysis.

In business firms generally the objective is to make a profit so forecast activities are concerned with production and sale estimation. Firms must determine how many demands they will receive for each kind of product in the future and how many of these demands can be met by their existing production capacity. PlossL and Wight believe that forecasting is an important action in every firm. They offer this definition:

Production control is concerned basically with the future. The past is beyond control. We must start from where we find ourselves now and prepare for the future. To do this, it is necessary to guess, assume or otherwise estimate what is going to happen from now on. All other things being equal, a company can survive only by preparing itself to meet its customer's needs at least as quickly as its competitors [32].

a. Sales Forecasting

Forecasting or determination of demand and requirements for some specific period of time in the future is one of the basic elements of logistics activities. An estimate of the future demand for different production or commodities is essential to almost any logistics decision-making. Future demands usually determine depth and range of the inventories of finished goods that must be provided. The level of inventories of finished goods affect the number of warehouses, transportation requirements, packaging and handling facilities. Thus, forecasts, particularly short term forecasts of demand, play a vital part in the production processes and also in the operation of a logistic system. A production process is any part of an organization that takes the labor, materials, energy and capital (inputs) and transforms them into finished goods or services (outputs). To what extent should the capability of the production process be utilized? What level of inputs make the production process efficient or effective? How far is it possible to change the variety of input in order to get more flexibility out of the system and eventually produce different output? All the questions are dependent upon the future demands and sales. If the level of sales are forecasted the quantities and qualities of output can be determined with the result that the appropriate range of input can be procured. Based upon the quantity of output established

for a period of time by marketing, sale, or production, logistics managers must determine all kinds of requirements for the entire firm for the same period of time. These requirements usually include equipment, raw material, common items, spare parts and components. An estimate of the future demands for each category of requirement forms the basic foundation of the logistics activities and basis for inventory planning.

Inventory like other assests ties up capital which can be put to other uses. A major role of the forecasting system is to define how much is really needed to be invested in inventory, particularly in short term. A forecast of demand for all requirements is necessary in deciding not only when and how much to replenish, but also, how much of an item to buy initially, where to stock it, and when and how much to dispose of.[11]. Forecasting helps the firm avoid opportunity lost cost. The accuracy of the forecasting method will influence the safety level that is required to be held. The more accurate the forecasting system is, the lower the level of saftey stock required, and consequently, a lessor amount of capital inhested in inventory. Forecasting generally starts with gathering and preparing the data, follows by making the forecast and finishes with tracking the forecast.

b. Characteristics of Forecasts

Several basic characteristics of practical forecasting follow:

(a) Forecasts are usually inaccurate. Forecasts are usually inaccurate because of universal difficulty of estimating supply and demand but it does not mean forecasts should be neglected. As indicated before, the value of the forecast does not necessarily depend on whether or not it comes precisely true, rather than its value can be recognized whenever the organization is better off due to the application of forecasting in decision-making.

(b) Forecasts for a short time period are generally more accurate than the forecasts for a long term period. For example, the forecast of average demand for next week will obviously be clearer than one for the corresponding week next year. Therefore, it is much more reasonable and appropriate to minimize forecast lead time in order to minimize forecast error.

(c) Forecasts must include an estimate of error. All forecasting models are based on historical data. These data can be accurate but there is no guarantee that they apply precisely in the future. That is why there is always some degree of error in forecasting future demand. The errors can be defined as a difference between actual demand and forecasted demand. If actual errors are known, a level of safety stock can be provided to protect against

such errors. Thus, whenever forecasts are made an estimate of error must be considered and also be included in the forecasts.

c. Making Forecasting Successful

Forecasting processes are composed of three different stages. In the first stage, after the purpose of the forecast is specified, the historical data should be collected and then analyzed. The purpose is to determine if anything can be learned from the history of previous demand. Because the aim is to reach the future demand, the historical data must be purged from those data that might not reappear again. Analyzing and purifying such data clearly requires adequate knowledge of past activities both in the market place and in the company.

The second stage of forecasting is to develop and refine a forecast model. The objective here is to find some practical, scientific forecasting techniques that can be applied within the organization according to the situation and environment that the company confronts. It must be understood that there is not any mathematical technique to handle the complexities of forecasting without management involvement. All mathematical techniques make the basic assumption that the patterns of the past will extend into the future. These methods and techniques may be so complicated and the formulas so sophisticated that complex electronic data processing equipment is needed for the

forecast or it may be so simple that it can easily be done manually. No technique or model is indicated as preferred, each method is designed for a specific situation and special environment and surely has its merit if it is applied in the proper way. Many managers believe it is really impossible to forecast future demand because it fluctuates widely from period to period, month to month or quarter to quarter. The author believes they mean that none of the forecasting methods they have practiced could forecast the future requirements perfectly, indeed, none of the numerous techniques that have ever been created can forecast demand perfectly. In fact, very good forecasting methods may give a wrong estimate more often than a right one. All that can be expected and asked from a forecasting method is that it be less inaccurate than some other forecasting techniques.

The third and final stage of forecasting is tracking the forecast. In this stage, actual demand and forecasted demand must be compared and actual error must be calculated. This is a very important action since it enables the company to react promptly when conditions change from the original plans. In order to make forecasting successful, first the forecaster should avoid those elements that are the cause of forecast failures. These elements can be described as:

- (a) Individual effort. It is not possible for an individual or small group within a single department to know enough about all the factors affecting the

future to define adequate forecasting. Thus, forecasting must be recognized as a group effort. Different departments that usually are involved in forecasting are marketing and production. Production uses the forecast from marketing to plan production, logistics uses the sale forecast as an input and interprets it to logistics forecast. One can also question why the logistic manager would be concerned with forecasting when sale demand would be forecast by marketing and then given to logistics as an input. The answer is that logistics managers need to do their own forecasting for inventory process and also be familiar with forecasting techniques of others, since it may be necessary for the logistics manager to recast the sales estimates, especially in terms of geographic requirements [7].

(b) Conflicting objectives. Major groups within a firm see the forecasting with different views. The sales group wants an optimistic figure, financial people prefer minimum level of forecast for low capital investment reasons, logistics people desire maximum quantities in order to be able to fill all inventory demands. To go along with all these opinions and objectives is not

possible. Thus, in order to avoid meeting greater error in forecasting methods instead of viewing these conflicting objectives all subsystems must recognize the objective of the system as a whole and cooperate toward an appropriate and coordinated forecasting method. The second consideration that makes the forecast successful is that the forecaster be knowledgeable about those elements that help the forecast be more accurate. These factors are generally defined as follows:

(b-1) The forecaster should know his field and have knowledge of the facts such as trade channels, historical trends, market situation, geographical factors, economic factors, trade expectation, and supply and demand history.

(b-2) All forecasts are based on assumptions. The forecaster should know and be prepared to state his assumption. These assumptions should cover both internal and external factors.

(b-3) The objective of the forecast must be clearly stated in terms of the question or questions to be answered.

(b-4) According to the data on hand, the forecaster should develop a hypothesis or tentative solution to be tested in the course of the study.

(b-5) Data pertinent to the hypothesis should be gathered, refined and carefully checked.

(b-6) No forecast should be accepted as final, all forecasts should be constantly reviewed in the light of the latest data [36].

In addition to the above factors the forecast should be for as short a period of time as possible. Also considerable emphasis must be put on reliable information since poor or incomplete information can jeopardize the outcome of a forecast or make forecasting a complete impossibility.

d. Forecasting Models

Forecasts of quantity demand play an important role in any inventory system. Random events, seasonal demands and general economic activity all influence the quantity of demand. Forecasting the level of demand is essential to good inventory planning because the time lags in replenishing the stock do not always allow adequate stock on hand to support all possible demands. As indicated before, it is not practical to seek a forecasting model that will predict exact levels of future demand. A forecast of future demand and requirement can be accomplished by different methods. None of these methods has priority over the other, as each should be used under different situations and conditions. The following are some of the most popular models that usually are applied for demand forecasting by business firms [36].

(a) simple moving average. Moving average is simply a numerical average of the last N demands that are used for the purpose of making a forecast. This method of forecasting is almost as simple as the "last-period" method. In "last-period" method, the sum of the demands during some specific period (i.e., month) becomes the estimate for the coming period (month). Moving average consists of summing all demands observed in the past and dividing the sum by the number of observations. By using data in Table II-1, and number of periods equal to 5 (N=5) moving average at the end of the fifth period can be calculated as:

$$\hat{M}_5 = \frac{25+22+30+26+22}{5} = 25$$

with assumption of constant pattern in the data, $\hat{M}_5 = 25$ will be used as future demand. The general formula for simple moving average can be defined as:

$$\hat{Y}_t = \frac{Y_t + Y_{t-1} + Y_{t-2} + \dots + Y_{t-N+1}}{N} \quad (1)$$

or,

$$\hat{Y}_t = \hat{Y}_{t-1} + \frac{Y_t - Y_{t-N}}{N} \quad (2)$$

Where \hat{Y}_t is simple moving average in period t, Y_t is the observed demand in time t and N is the number of periods. The simple moving average for N=5 are calculated for all period in Table II-1. These data are also plotted in Figure II-1.

This model is usually appropriate when the demands are basically constant.

TABLE II-1
Simple Moving Average, N=5

Period	Demand (100 Units)	Simple Moving Average	Period	Demand (100 Units)	Simple Moving Average
1	25	-	11	25	29
2	22	-	12	42	32
3	30	-	13	30	30
4	26	-	14	21	29
5	22	25	15	22	28
6	30	26	16	35	30
7	27	27	17	47	31
8	40	29	18	40	33
9	26	29	19	31	35
10	27	30	20	20	32

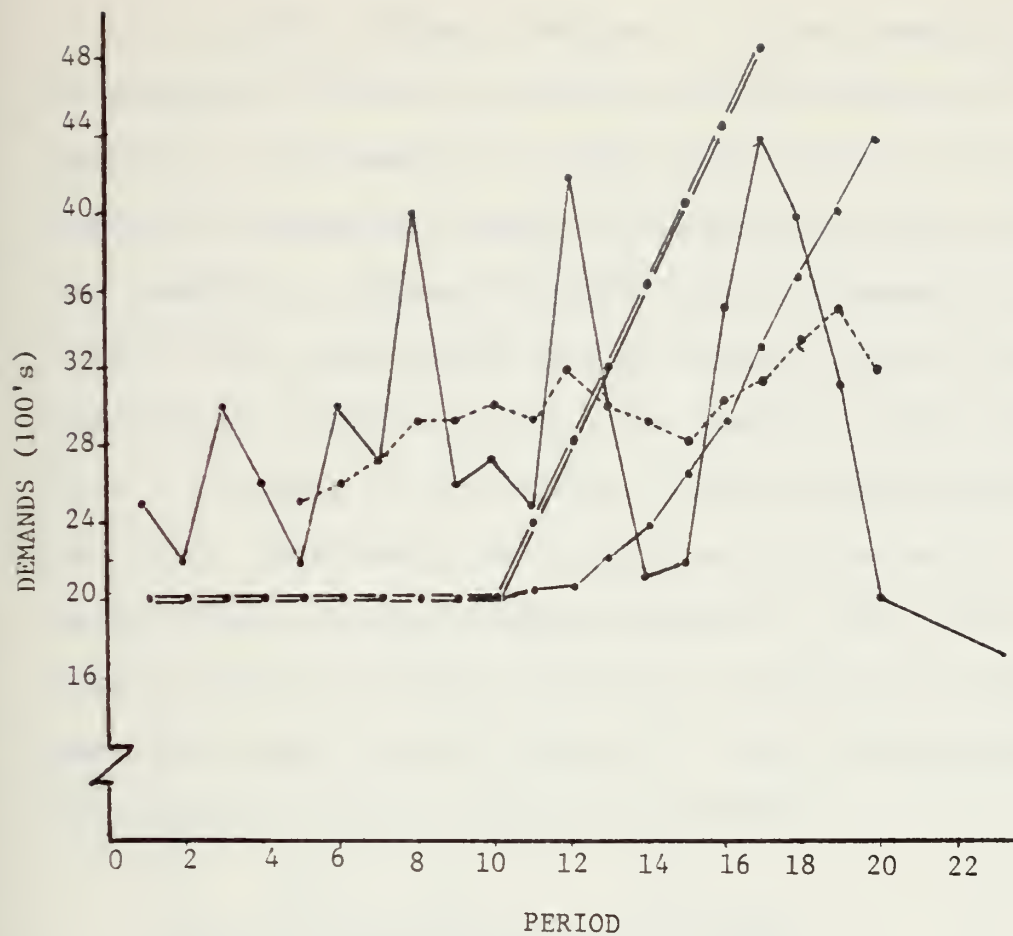


FIGURE II-1
Geographical Presentation of Simple and Double
Moving Average Data Presented in Table II-1

(b) Double Moving Averages. If the demands have a linear or quadratic trend, the simple moving average will be misleading. For example, in Table II-2, for the first ten periods, demands are completely stable but from period eleven, the demand is increased by 400 units of demand in each time period. By using simple moving average these increased demands will continue to lag. The amount of this lag is called bias. In order to correct the bias the simple moving average should be improved by developing another equation that is called double moving average equation. For doing so the simple moving averages should be treated as an individual demand and then a moving average of these averages be calculated. The general formula will be as follows:

$$\hat{\hat{Y}}_t = \frac{\hat{Y}_t + \hat{Y}_{t-1} + \hat{Y}_{t-2} + \dots + \hat{Y}_{t-N+1}}{N} \quad (3)$$

Where $\hat{\hat{Y}}_t$ is double moving average in period t, \hat{Y}_t is simple moving average in period t and N is the number of time periods. When double moving average of each period is calculated by applying the following formula the future demand can be computed.

$$\hat{\hat{Y}}_{t+k}^o = a_t + b_t \cdot K \quad (4)$$

$$a_t = \hat{Y}_t + (\hat{Y}_t - \hat{\hat{Y}}_t) = 2\hat{Y}_t - \hat{\hat{Y}}_t \quad (5)$$

$$b_t = \left(\frac{2}{N-1}\right) (\hat{Y}_t - \hat{\hat{Y}}_t) \quad (6)$$

Where (\hat{Y}_{t+k}^0) is future demand for (K) period(s) from present period (t), \hat{Y}_t and $\hat{\hat{Y}}_t$ are simple and double moving averages in period t, respectfully. The double moving average is appropriate method when the demands have linear trends. Data in Table II-3 are also plotted in Figure II-1.

TABLE II-2

Double Moving Average, N=5

Period	Demand (100 Units)	Double Moving Average	Period	Demand (100 Units)	Double Moving Average
1	20	-	11	24	20.16
2	20	-	12	28	20.64
3	20	-	13	32	22.16
4	20	-	14	36	23.76
5	20	-	15	40	26.16
6	20	-	16	44	29.2
7	20	-	17	48	32.72
8	20	-	18	52	36
9	20	20	19	56	40
10	20	20	20	60	44

(c) Simple Exponential Smoothing. By using the simple or double moving average methods it is relatively easy to calculate the future demand, whenever N is small and the variety of goods or items are limited. However, in general, applying these methods requires a relatively large amount of historical data. For example, if an enterprise wants to predict the future demand for 500 different items regarding 100 periods (N=100), then it has to keep $500 \times 100 = 50,000$ data points. If the enterprise keeps none of the data, then value of the demand for each period will not be available. In this case the best estimate of demand for each period can be computed as follows:

$$\hat{Y}_t = \frac{1}{N} Y_t + (1 - \frac{1}{N}) \hat{Y}_{t-1} \quad (7)$$

Equation (7) could be used to calculate \hat{Y}_t , if no data were available. By substituting $\alpha = 1/N$ and $\hat{S}_t = \hat{Y}_t$ in equation (7), the general simple exponential smoothing formula can be reached.

$$\hat{S}_t = \alpha Y_t + (1 - \alpha) \hat{S}_{t-1} \quad (8)$$

New estimate = α (new data) + $(1 - \alpha)$ (previous estimate)
 where α , is called the smoothing constant (usually between .01 and 0.30) \hat{S}_t , new estimate of demand in period t, and \hat{S}_{t-1} is demand estimate in period t-1, relation between α and N can be computed by using equation $\alpha = \frac{2}{N+1}$. Table II-3 shows the simple exponential smoothing for related data.

(d) Double Exponential Smoothing. In order to take account of a linear trend in data, it is essential to calculate double exponentially smoothed statistics because the simple exponential smoothing model is based on a constant demand with only random disturbances. Thus, whenever there is a definite trend in the demand series (either positive or negative) it is appropriate to apply double exponential smoothing model in order to reflect and adapt the increasing demands. The general double exponential smoothing formula at time period t , (\hat{S}_t) can be defined as:

$$\hat{S}_t = \alpha \hat{S}_t + (1-\alpha) (\hat{S}_{t-2}) \quad (9)$$

In order to be able to calculate \hat{S}_t first the value of \hat{S}_0 and \hat{S}_0 must be estimated. In those cases where a relatively large amount of data are available then initial estimates (\hat{S}_0 and \hat{S}_0) are not very important and could be neglected, but in those cases with few data points (less than 15 or 20) the initial estimates are required and must be defined. By using equation $Y_{t+K} = a_t + b_t.K$, the future demand can be computed, where K is the number of time periods from the present period (t), to the desired period. a_t and b_t could be calculated by applying the following equation:

$$a_t = 2\hat{S}_t - \hat{S}_t \quad (10)$$

$$b_t = \frac{\alpha}{1-\alpha} (\hat{S}_t - \hat{S}_t) \quad (11)$$

Table II-3 shows the double exponential smoothing for related data.

TABLE II-3

Exponential Smoothing, $\alpha=0.30$

Period	Demand (100 Units)	Exponential Smoothing	
		Simple (\hat{S}_t)	Double ($\hat{\hat{S}}_t$)
0	-	50.00	50.00
1	50	50.00	50.00
2	52	50.60	50.18
3	47	49.52	49.98
4	51	49.96	49.98
5	49	49.67	49.88
6	48	49.17	49.67
7	51	49.72	49.68
8	40	46.80	48.82
9	48	47.16	48.32
10	52	48.61	48.41

e. Forecasting Levels

Forecasting generally is grouped in three different levels:

(a) Long run forecasts, which usually deal with the next three to ten years. In this level, fixed requirements for new plant (company expansion) machinery, equipment, warehouses, and new construction will be defined.

(b) Medium term forecasts which usually deal with one year and is used to plan production in the face of highly cyclical demand or raw material supply.

(c) Short run forecasts usually for one week to three months used to monitor production levels and control stock replenishment.

Model Selection:

Sound predictions of demands and trends are no longer luxury items, but a necessity if the manager is to cope with seasonality, sudden changes in demand levels, price-cutting maneuvers of the competition, strikes, and large swings of the economy. Forecasting can help him deal with these troubles; but it can help him more, the more he knows about the general principles of forecasting, what it can and cannot do for him currently, and which techniques are suited to his need at the moment [36].

In recent years many different forecasting methods have been developed in order to enable managers to handle managerial forecasting problems. Each of these models has its special use, thus, care must be taken to select the appropriate technique for a particular application. The selection of a

method depends on many elements, such as: the context of the forecast, the relevance and availability of historical data, the time period, the degree of accuracy and the value of the forecast to the company. These factors must be considered constantly with collaboration between the manager and the forecaster. In addition to the above factors, there are some general criteria that help the company to compare and evaluate different forecasting methods and select the most appropriate one. These criteria can be defined as:

(a) Evaluation of Mean Absolute Deviation (MAD).

Since all forecasting models are based on historical data, prediction of future demand will generally be in error to some degree. The forecasts not only should include the future demand but it also should cover the error. An error is defined as the difference between actual demand and forecasted demand. Absolute deviation in forecasting can be computed as follows:

Absolute Deviation = (Actual Demand - Forecasted Demand)

By calculating the mean absolute deviation (MAD) that is average of a number of individual forecast errors the degree of error for each model can be calculated.

$$MAD = \frac{\sum_{t=1}^n Y_t - \hat{Y}_t}{n} \quad (12)$$

Where Y_t is actual demand in period, and \hat{Y}_t is forecasted demand for the same period. When (MAD) for a different

model for a series of data is defined (for the same period), that technique which yields the minimum (MAD) is preferred to others.

(b) Evaluation of Mean Square Error.

The mean square error of each model could be computed by using the following formula:

$$MSE = \frac{\sum_{t=1}^n (Y_t - \hat{Y}_t)^2}{n} \quad (13)$$

Again, that model is preferred to others that yield minimum mean square error [31]. It should be noted that the same data and their related time period be applied for computing the MSE in each model.

2. Procurement

Every economic entity, whether it be a family, a business, or a government must decide how to procure its requirements, the requirements which frequently vary as to quantity and quality. It is true that all these economic entities may satisfy their needs and ultimately procure what they believe are required, but do all these entities procure their requirements in the right quality or with reasonable prices? Do they get maximum utility and benefit from their scarce resources? The answer is usually negative. Procurement functions are not limited to finding and buying the requirements, rather they include many other factors such as:

- (1) What are the proper equipments, materials and supplies?
- (2) What quantity of each item must be procured?
- (3) When and where must the requirement be available?
- (4) From which supplier and at what price must requirements be purchased?
- (5) Must the requirements be purchased or can they be made?

Thus, to come up with appropriate answers to the above factors a proper procurement system is essential in any logistics organization.

The purpose of this section is to present a definition of procurement, step of procurement, quality and quantity determination, quantity and quality control function, making or buying concept and their relative advantages, and finally discuss those factors which affect decision making regarding how to procure.

a. Definition

Procurement is one of the important parts of the logistics process including: purchasing, renting, leasing, or otherwise obtaining supplies or services. Procurement as a logistics element lies between requirements and distribution and so includes some of each of these elements. Procurement obviously is based on the determination of requirements and therefore is largely dependent on the present or future availability of manpower, material, facilities and services. Procurement

occurs at all levels of an economic entity: family, private enterprise, and government agencies, but the different aspects and expectation can generally be categorized as: consumer and commercial aspects.

Procurement as a consumer point of view is characterized by a shopping basket philosophy, that indicates between two market baskets the consumer can decide where he prefers the first market basket to the second, whether he prefers the second to the first, or is indifferent. Clearly the most important factors which determine a consumer's decision are his tastes and preferences [26]. Obviously the goal of a rational consumer is to maximize the total utility or satisfaction he derives from spending his income. The consumer reaches this goal or is said to be in equilibrium when he spends his income in such a way that the utility or satisfaction he receives from the last dollar spent on different commodities is the same. Mathematically this can be expressed by:

$$\frac{M_{ux}}{P_x} = \frac{M_{uy}}{P_y} = \frac{M_{uz}}{P_z} \quad (14)$$

subject to consumer income which is:

$$P_x Q_x + P_y Q_y \dots + P_z Q_z = M \quad (15)$$

where:

M_{ux}, M_{uy}, M_{uz} = degree of satisfaction drives on commodities x, y and z.

P_x, P_y and P_z = relative prices of commodities.

Q_x, Q_y and Q_z = quantity of respected commodity that consumer is willing to buy.

M = Consumer money income.

In short, the philosophy indicates every customer has freedom to choose the nature and quality of items required and also to choose the appropriate supplier.

Procurement as a commercial point of view is completely different from that of an individual consumer. Wilbur and Michiel indicate:

Commercial procurement presents a totally different picture. The needs of most organizations are often specialized, and the volumes of purchase tend to be large. The number of potential sources may be small, and there may be few customers in the total market [13].

There is no doubt that there are many differences between consumer and commercial acquisition. Many commercial organizations acting as a buyer are even larger than their individual suppliers.

b. Steps of Procurement

Steps of procurement described by different authors may be different from each other in arrangement, but all logisticians agree that procurement starts with the identification of

need and funding. Steps of procurement should be followed one by one whenever possible. This does not mean that these steps must necessarily be followed in exact sequence. Sometimes many variables such as urgency of requirement, type of goods and services required, complexity of the procurement and law and regulation make it impossible that these steps be followed in an exact sequence. The essential steps of procurement can be described as follows:

- (a) Identification or recognition of needs and funds.
- (b) Clear statement of characteristics and quantities required.
- (c) The transmission of the purchase requisition.
- (d) Identify the proper source of supply and request proposal.
- (e) Obtain different proposals from different suppliers and analyze all of the proposals and choose the best vendor.
- (f) Place of the order or award the contract.
- (g) The follow-up action.
- (h) The receipt and inspection of commodity and material.
- (i) Receipt and check the invoices.
- (j) Claim for items which have been rejected.
- (k) Payment.
- (l) The completion of record.
- (m) Performance feedback and evaluation.

c. Quality

Quality is an important factor in all phases of procurement; it can be categorized as low, medium or high grade. Quality from an individual buyer's point of view usually is thought of in terms of the price he expects to pay. He assumes that price will be low, medium or high depending upon quality. Quality in a business organization has quite a different meaning and it cannot be measured in terms of a price. On the quality market business must apply a special means or measurement when it is buying raw material equipment and components to produce some finished product. Actually quality is a set of characteristics and is determined by the need for a specific purpose. As the objective in business is to make profit, the required quality must be obtainable at a price that enterprise can afford to pay and still make a profit. Wilbur and Michiel indicate:

Quality is a combination of characteristics, not merely one. The specific combination finally decided on is almost always a compromise, since the particular aspect of quality to be stressed in any individual case depends largely upon circumstances [13].

Sometimes the first consideration is reliability and sometimes other factors such as lifetime cost, efficiency in production, or repair facilities are the most important. Briefly, what constitutes a satisfactory quality, therefore, depends largely on what a company is seeking.

- Quality Determination:

One of the basic principles of procurement is to recognize exactly what quality is needed, for a specific purpose or requirement, then describe that quality accurately so that the suppliers (outside companies) or the company itself can inspect. The commodity received against some well known standard and assure itself that its needs are being satisfactorily fulfilled. Determination of quality may be fixed by the producer's customers, defined by one or more of the producer's departments, or established by engineering. The engineering department is the authority for determining quality in many cases. Purchasing has always the right to question quality suggestions made by other departments. It may make its own recommendation according to the nature of items which are going to be bought such as raw materials, supplies, equipment and parts or components. The criterion for determining the correct quality may vary:

(a) For raw materials usually engineering ranks first as determining authority; second is procurement and third will be production. Sometimes if the price of raw materials covers a high percentage of total expenditures of the company, quality may be determined by a special committee of top managers.

(b) If supplies are going to be purchased, quality usually will be defined by procurement as a first authority

and production as second; in this case engineering has a small role. In reality if a department is a large user of the supplies or has a powerful manager it may influence the procurement division.

(c) Decisions concerning quality determination for equipment generally should be made by the engineering department. In many cases, because machinery and equipment are bought for the long usage and usually need large investment, after quality is defined by the engineering department the actual purchase will be determined by a committee composed of engineering, production, procurement and top managers.

(d) Finally, quality of parts or components will usually be determined by the engineering department and then will be followed by procurement and production departments.

Many companies or organizations have created standard quality for their requirement because both higher or lower quality than standard may create loss. Both plus or minus variations beyond the allowable limits are undesirable. However, in real life to procure a specific standard quality not only is sometimes difficult but in many cases is unfeasible, especially for those companies which have requirements from other countries.

Quality can be described in different ways. It does not make any difference which ways or which forms have been applied, but it is very important to choose a methodology by

which a buyer can convey to a seller a clear, accurate picture of the required item. Some methods of description for quality determination can be listed as follows:

- (a) description by brands (trade names)
- (b) description by specification
- (c) description by drawing or picture
- (d) description by sample or market grade
- (e) description by commercial standards
- (f) description by combination of two or more of the above.

Quality Control:

When the quality of items is determined, there are still some elements that if neglected can cause excessive cost. These elements are composed of those actions which ensure that the right quantity of items has been purchased and the exact quality has been received. To give satisfaction to the buyer the quality that is ordered must be controlled. The control can be by some form of inspection. It can be done by the buyer or vendor or both. Quality control from the seller's point of view is to ensure that its final finished goods cover exactly the required quality. Usually this should be done during the production process by general inspection and control action. Quality control from the buyer's point of view is to gain assurance that the items received have precisely the quality specified. The important point is that the buyer should not consider the seller's inspection as his control.

Whether the seller has inspected his products or not is completely dependent on the seller's policy and situation. Occasionally a seller may want to reduce production costs to a point where quality suffers, thus for many reasons, it is poor policy for a buyer to neglect thorough inspection. The scarce resources that have been allocated to development of satisfactory specifications are wasted unless adequate inspection and control steps are taken to ensure that the required quality is met.

The extent to which inspection should be carried depends on the circumstances and nature of the items. Expensive or crucial items should have carefully supervised inspection. In short, there can be too many inspections as well as too few. Choice of the appropriate procedure must be reviewed and considered far in advance by company, as either buyer or seller. What criteria should be used in determining whether inspection is in fact justified? Two factors which should be analyzed before the decision is made are:

- (a) What are the costs of inspection?
- (b) What are the costs resulting from defective items entering production operation or reaching the customer?

An attempt to minimize the sum of the above costs is the guiding criterion in arriving at the basic inspection decision. A mathematical formula can be applied to compute the total cost in either case; (a) do inspection or (b) do not do inspection.

$$(a) \text{ Do inspection: } T_c = (N \times I_c) + \{P(n) \times D_c\} \quad (16)$$

Where T_c - total cost

I_c = inspection cost of each item

D_c = cost of each defective item

N = number of items received

$P(n)$ = proportion of defective items accepted
in per lot

n = actual number of defective items in
per lot.

$$(b) \text{ Do not do inspection: } T'_c = n \times D_c \quad (17)$$

If T_c is less than T'_c , ($T_c < T'_c$) it is least costly
to inspect all items.

If T_c is greater than T'_c ($T_c > T'_c$) it is least costly
to inspect none of the items or inspect a sample only.

If T_c is equal to T'_c ($T_c = T'_c$) the break even point
is reached $(N \times I_c) + \{P(n) \times D_c\} = n \times D_c$. Inspection
costs can be reduced if sampling model is selected
rather than 100% inspection model.

In cases where $T_c = T'_c$ or $t_c > T'_c$, it is reasonable to
choose a sampling system in order to reduce inspection cost.
The question is how to determine the sampling size? Sampling
size can be determined either by estimating the population
mean (μ) or population proportion (π), if it is desired to
estimate the population mean (μ) so that the estimate \bar{x} will
be no more than A units from the true value of (μ) with con-
fidence $(1-\alpha)$ and \bar{x} is approximately normally distributed
then sample size (n) should be chosen such that:

$$n > \left| \frac{Z_{\alpha/2} \sigma}{A} \right|^2 \quad (18)$$

where $Z_{\alpha/2}$ is the value on the standard normal distribution such that probability $(Z > Z_{\alpha/2}) = \alpha/2$ and σ is the population standard deviation and \bar{x}_n = sample mean. If it is desired to estimate the population proportion (π) so that the estimate (\hat{p}) will be no more than A units from the true value of π , with confidence coefficient $(1-\alpha)$, and it is assumed that (\hat{P}) is approximately normally distributed, then sample size (n) must be chosen so that:

$$n > \left| \frac{Z_{\alpha/2} (0.50)}{A} \right|^2 \quad (19)$$

where $Z_{\alpha/2}$ is the value on the standard normal distribution such that probability $(Z > Z_{\alpha/2}) = \alpha/2$ and \hat{P} is sample proportion.

d. Quantity

When quality is defined the next step is to determine the quantity that must be procured.. It was explained earlier — principles of sound procurement require that the desired quality of items be precisely determined and accurately described. The defined quality could be unchanged unless the company gains knowledge of different materials to fill its needs. With quantity, however, there is no such stability; it is ideal to buy material or supplies whenever they are needed, and deliver directly to a department using them. In this situation, obviously, quantity to procure would be the

quantity needed by the using department. In reality this ideal situation is almost never reached because of the following.

(a) The quantity required can very seldom be forecast exactly because of the difficulty of estimating supply and demand.

(b) Distribution factors are often faced with unexpected situations that directly affect the availability of items.

(c) Economic principles lead the large scale companies to buy their requirements in large quantities rather than in small quantities. The desired quantity from a production point of view is not known primarily because of difficulty of forecasting demand. Thus, there are many other factors besides a department's needs that must be carefully considered in determining of the quantity that must be procured. Generally, the following factors should be considered in determining quantities to be purchased. Of course, it must be understood that all of these factors do not apply equally to all companies, nor indeed to all commodity classifications in the same company.

- Quantity of item on hand
- Time and extent of probable use
- Carrying cost

- Ordering cost
- Stock-Out cost
- Stability of supplier (lead time)
- Discount price
- Transportation cost and availability
- Production variation
- Possibility of strike and work stoppage
- Market condition and price trends
- Customer service policy.

The quantity of items to be procured directly affects the investment capital and thereby the opportunity cost, also the right quantity determination avoids stock-out cost or extra carrying or ordering cost. It is important, therefore, that the people who are going to be involved in quantity determination be completely aware of the company's plans, marketing situation, company's objectives, constraints and capability. The question arises: who are these qualified personnel? In what level of the hierarchy are they assigned within the organization? The answer (in many cases) is, quantity determination is as important as almost any other decision. Obviously, in these cases a committee of top management should determine the basic policy for quantity to be procured. The members of this committee would usually represent engineering, production, finance, sales and purchasing. Sales and production have clear ideas about commodity needs based on future

production and sales. Engineering can usually help in design changes or other technical aspects of the requirement. Finance looks at the subject with respect to the financial condition and finally, procurement, as the most objective member of the group, will be in a position to weigh the arguments of all the members and aid in arriving at a compromise conclusion. Clearly, the members of the committee will vary between companies; sometimes it will vary within the company itself. The nature of items, value of items, importance and priority of items, company goals and policy are some factors that simply would change the membership of the committee. The composition of the committee can be varied in different companies but one of the important points to be considered in all companies is that the people involved in quantity determination must be qualified and knowledgeable so that they can investigate and make proper decisions in the following areas:

- (a) Can the quantity needed be based on exact requirement
- (b) Must the quantity requirement be based on minimum and maximum stock level
- (c) Should the quantity requirements be based on time coverage
- (d) Should the quantity needed be based on market price and situation
- (e) What is the affect and relationship between the quantity required and cost and benefits within the company?

Quantity Control:

Quantity determination and quantity control must be considered as two sides of a coin if the best utilization of the items procured is to be assured. In other words, a good quantity determination system is not sufficient unless a proper quantity control system is also activated. Deficiency in either one affects the result of the other and ultimately causes unsatisfactory results in the procurement system as a whole. Howard argues in favor of the material quantity control system and indicates:

The ideal requirements of a quantity control system which ensures meeting the demands made upon it are comparatively simple to state, one would say perhaps that there are four: simplicity, flexibility, accuracy and timeliness [21].

These elementary principles are not always followed in all companies and organizations. Of course, it does not mean that the principles are soundless but it is a reflection upon management style. However, the application of these principles is far from simple, and to have a responsive material control system these functions must be performed adequately and realistically.

e. Make or Buy

In any business organization every time a purchasing order is made out something will be purchased, and every time a production order is given something will be made. Behind each purchase order there is a decision to buy and not to

make, and behind each production order is a decision to make and not to buy. How far these decisions are appropriate and reasonable depends on how well the business has evaluated its different alternatives, and how accurate the expected monetary value or expected utility of the best course of action has been computed and weighed. Many business organizations may believe and indicate that they do not have any make or buy problems, or at least they think make or buy problems are not the perplexing problems. Perhaps one of the reasons that some companies believe so is because they have not realized make or buy problems. If these problems are not recognized by some, it does not mean that they do not exist. In reality make or buy problems do exist and can be of real importance in the conduct of business. The question is, what are the criteria and principles that must be analyzed to lead the manager to select the best course of action whenever he is faced with make or buy alternatives and choices? The Handbook of Purchasing Policies and Procedures approach make or buy as:

The fairest statement that can be made is that each case must be considered upon its individual merit, and that there are so many considerations as to make any generalization practically impossible [15].

The author believes there is a little exaggeration in the above definition. Clearly, make or buy analysis and decision making varies for different cases but there are some criteria that can be generally applied and should be concerned whenever a make or buy decision is going to be made. Make or buy is

mainly a problem in the selection of a source of supply, the determination of the best source from which to obtain the materials and supplies needed in a business. The source of supply can be selected either among outside vendors or between outside vendors and the company itself. The objectives are to obtain the right materials, at the right time, in proper quantities and at as little cost as possible. Thus, that source of supply which is most likely to enable a business to attain these objectives is desirable. This is true whether the source selected be one or more of several outside vendors or the company itself. Consequently, if making rather than buying can help a business better attain those objectives, making is preferable to buying. The general criteria that usually helps solve make or buy problems and select appropriate source of supply can be described as:

(a) Cost in broad sense: Since business is run for profit any action which produces less profit than another action can be said to cost more than that other action. In broad sense cost is measured according to the economic concept and for the long run, thus, for make or buy decisions all cost, tangible and intangible, must be evaluated and the least costly course of action adopted.

(b) Cost in a narrow sense: Cost of making or buying must be represented in dollar value in such a way that it can be realized how much does it cost to buy part A and how much does it cost to make part A. Cost in a narrow sense measures

the dollar value of the tangible and relevant cost which can be traced either by purchasing or making a specific item.

(c) Quality: Quality of an item can be a reason for making whenever appropriate quality cannot be purchased from outside vendors. Quality also can be a reason for buying whenever the proper quality cannot be made by the company itself.

(d) Quantity: Quantity of items required can be a reason to make whenever a company wishes to be:

- Independent of disturbance, whether by strike or otherwise from outside source of supply.
- Independent of transportation delays, difficulties and costs.
- Whenever the quantity of an item is so small and needs a special order and outside industry will not accept to produce the item (quantity can be a reason to buy rather than to make whenever the quantity economical to make exceeds the quantity needed).

(e) Plant capacity: Plant capacity plays an important role in make or buy problems if the capacity of the plant is not completely utilized, managers may feel a need to increase the output of the plant by increasing the inputs. In this situation usually fixed overhead costs independent of production output will remain constant and costs of variable elements (material, labor, and variable overhead) will vary. Thus, the plant capacity can be utilized to the extent that variable cost incurred because of producing new items does

not exceed the cost of purchasing that item from outside suppliers. Figure II-2 is an example that indicates when utilization of plant capacity is increased by 20 percent (from 67.6% to 81.1%). The total cost of production is increased only 15 percent. Obviously, this is a favorable situation (production volume increased by 20 percent).

(f) Other factors: Other factors which can be considered for make or buy decision-making are:

- surplus funds
- employee relations
- vendor relations
- security of supply
- possible legal conflicts.

After appropriate analysis is done a company can simply choose the best alternative with respect to its goals and optimum benefits. Obviously, final decision would be either to make or buy.

- (1) If it was concluded that the best alternative is to make, then the company production steps should be followed (these steps will not be argued in this thesis).
- (2) If to buy is the best alternative and optimum solution then the company purchasing procedure must be followed to procure the requirements.

Advantages of Buying:

Without knowing the specific conditions under which a make or buy problem arises it is impossible to place a value

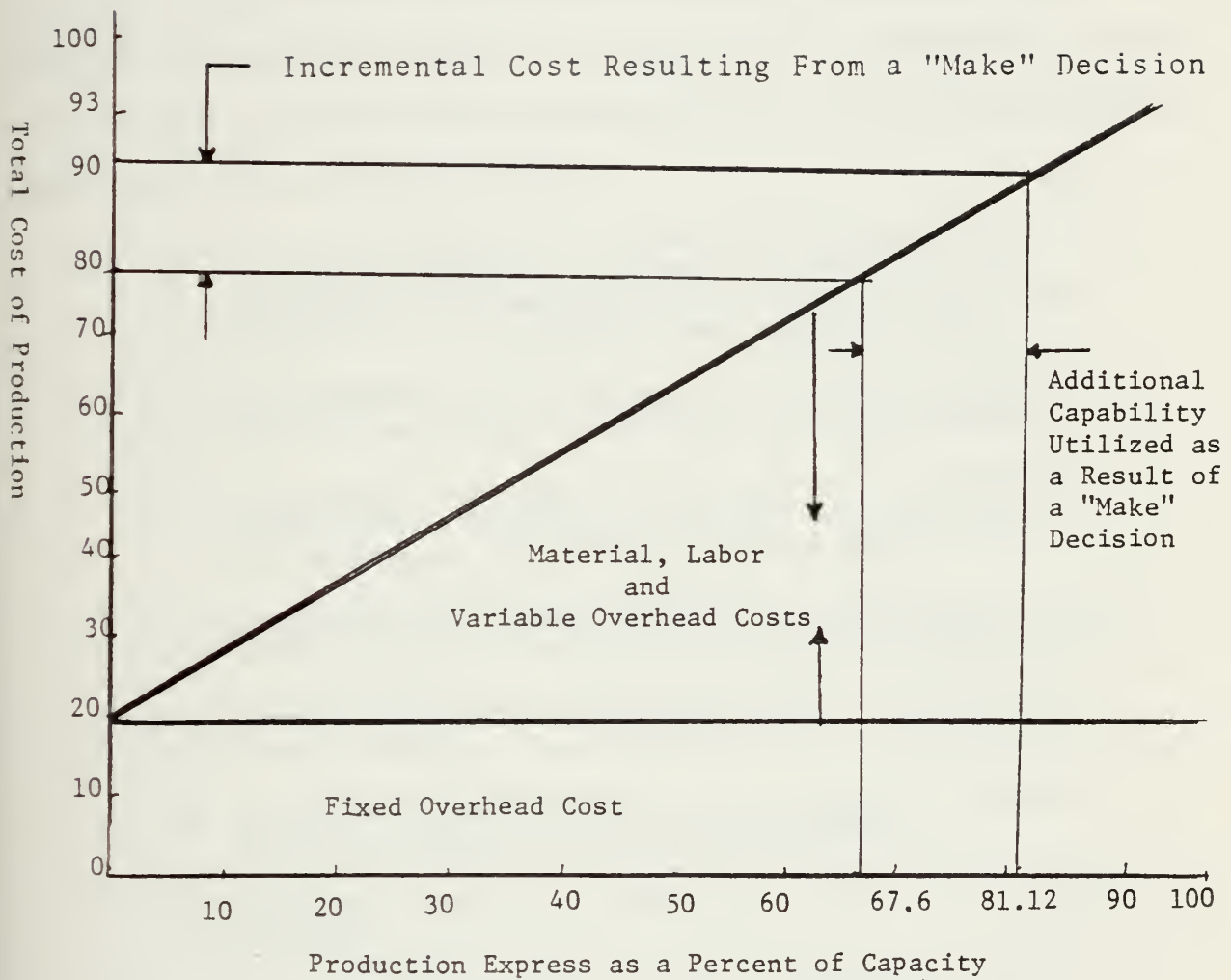


Figure II-2

An example showing how increased use of plant capacity can be profitably utilized

upon the make or buy decision. In other words make or buy is a complex question and often the subject of many arguments. In general, however, some advantages can be defined for both make and buy problems but for specific situation, managers should not be limited and convinced only by arguing these general advantages. Rather, as explained in section 8, detail and accurate analysis must be done before any decision is made. Some advantages of buying are:

- (a) the experience of a specializing supplier in many instances is just as conducive to producing the best possible quality (for the purpose) as a company's own organization.
- (b) The benefits of outside supplier's research facilities become available to the purchaser.
- (c) Purchasing maintains flexibility in changing suppliers, changing the items being bought, and changing the final finished goods.
- (d) Purchasing problems related to achieving defined quality will be passed to someone else.
- (e) More possibility to procure small volume with less expense.
- (f) Utilize the limited plant capacity for those products which provide more benefit.
- (g) More possibility to maintain a multiple source policy.
- (h) Indirect managerial control consideration.

Advantages of Making:

- (a) inspection sometimes may be less expensive if parts are made.
- (b) Production method can be kept secret.

- (c) Productive use of excess plant capacity can be used to help absorb fixed overhead.
- (d) Maintain a stable work force.

f. Purchasing

The materials that go into a typical company product originate from two sources: the company's manufacturing department and the purchasing department. Purchasing not only buys raw materials which production converts into fabricated parts but it also buys finished fabricated parts. In general usage, the term purchasing describes the process of buying: learning of the need, locating and selecting a supplier, negotiating price and other pertinent terms and following up to ensure delivery.

(a) Purchasing Function:

Purchasing is an integral and essential part of logistics systems. All the functions of business logistics must mesh into a unified whole if logistic management is to fulfill its basic responsibility of maximizing company profits. Each function must share in this basic responsibility. The purchasing function is broad indeed. It covers all aspects imaginable of the flow of purchased material--from preparing the requisition and issuing purchase orders to obtaining the material and releasing it to warehouses or manufacturing departments [29].

(b) Objectives of Purchasing:

The classical objective of purchasing is to buy the requirements and services of the right quality, in the right

quantity, at the right price, from the right source and at the right time [29]. The definition sounds logical enough but in reality how these "rights" can be achieved is not easy. It cannot be denied that reaching these objectives depends on many factors: the right quantity cannot be purchased if forecasting is inaccurate; the right quality will not be met if the appropriate characteristics of desired quality is not defined; the source of supply may not be right if adequate sources are not available; the right prices are not clear if the market place is monopolized and; the requirement could not be ready at the right time if there are some constraints in delivery means and facilities. The manager must be concerned with reality according to environment and constraints, he or she must try to achieve those "rights" that are really feasible.

Regardless of the above definition, purchasing has other objectives that can be described in general management terms. These objectives are as follows:

- to support company operations with uninterrupted flow of materials and services.
- To buy competitively and wisely in order to pay reasonably low prices for the best value obtainable.
- To keep inventories as low as possible.
- To develop satisfactory sources of supply.
- To secure good vendor performance.
- to make payoff analysis in order to reduce the cost of purchases.

- To keep top management informed of material developments which could affect company profit or performance [29].

(c) Purchasing Methods:

Different companies may use different methods of purchasing but have the identical objective of buying materials and services of the right quality, in the right quantity, at the right price from the right source and at the right time. The probability of achieving the above objective largely depends upon which method of purchasing is applied within the enterprise and how well the selected method is implemented. Purchasing methods have been categorized as: forward buying, speculation, hand to mouth buying and gambling [23]. All purchasing methods under different names and definitions generally can be included in two dependent categories: purchasing without previous agreement or contract, and purchasing with previous agreement or contract.

Purchasing without previous agreement or contract: This kind of purchasing is usually used for quantities and for short periods of time. It is doubtful whether there is a purchasing manager or buyer anywhere who likes small orders, in fact, small orders are disliked by sales as well as purchasing personnel because these orders waste both time and money. Small orders affect costs in the following ways:

- buyers time. The purchasing manager or buyer must spend a certain amount of time on every requisition received.

- Freight costs. Since most commercial transportation firms operate under a minimum weight or size system of rates, it is obvious that freight costs for small orders are higher than such costs on a large order.
- Unit price. When the quantity purchased is so small the buyer cannot take advantage of discount rates which usually are given for higher quantity.
- Purchasing cost. When the quantity purchased is small the number of purchasing orders for a specific period would increase, as a result, purchasing and ordering cost will increase.

Purchasing with previous agreement or contract:

This category refers to large quantity orders and usually for long periods of time, one year or more. Procurement under the purchasing contract method not only avoids those costs associated with small orders, but also motivates and ensures the seller to utilize its plant capacity more effectively with a resulting decline in production costs. This in turn can reduce the price of the finished goods. In addition to the above advantages, purchasing under contract system will improve delivery, provide more opportunity for adequate control, will simplify work, and will reduce administration expenses.

- Storage:

Storage as an element of logistics systems involves two separate but very related activities. Namely, inventory management and warehousing. Both these activities are

directly and closely related to transportation factors. As the transportation facilities increase, the level of inventory being held may decrease. Decrease in inventory level may reduce the number of warehouses.

g. Warehousing

Haskett, Ivie and Glankowsky, state:

to the extent that inventory control is the heart of the logistics function the warehouse is the veritable center of the logistics system for any one firm [25].

Warehouses serve as processing or material handling stations in the logistics system. The major functions of a warehouse are: to receive material and goods, to identify and store them, and protect and issue them.

Nature and importance of warehousing:

Warehousing is often defined as the storage of goods prior to their use. Broadly interpreted, this definition includes a wide spectrum of facilities and locations which provide warehousing, such as open field storage of iron ore, storage of raw materials and finished goods, and highly specialized storage facilities such as farm product storage for beans and grain and products which require refrigeration, etc.

Warehousing absorbs the shock caused by inflation of demand or supply. Warehousing creates reliable resources for continuous operation and lessens loss of sale even in unexpected marketing situations. The major advance of warehousing lies in creation of time utility for raw materials, and finished

goods. The proximity of market oriented warehousing to the customer allows the customer to be served near points where desired. More importantly, warehousing increases the utility of goods by extending or broadening their availability on a time basis to prospective customers. The basic demand for warehousing is determined by the quantity and variety of commodities that require storage. Thus, warehousing exists because companies inventory commodities. Inventories can be divided into two general categories - physical supply (raw materials) and physical distribution (finished goods). Both types of inventories are stored for similar reasons. In almost all companies, transportation and production economics are paramount reasons for creating inventories. The cost savings in transportation alone are sufficient to cause many companies to warehouse inventories in order to take advantage of them. Stopping the production line is usually harmful and expensive. Never shutting down the line for lack of raw material is a common rule in many organizations. To avoid this situation, adequate stock of raw materials are maintained. Efficient and balanced production runs for different products also dictate that sufficient warehouse space for finished goods be provided [7]. In summary, it can be said that uncertain consumption patterns, variation in production levels, and fluctuations and uncertainties in the price of physical materials along with the high cost of instantaneously responding

to uncertain economic conditions, are the primary reasons for a warehousing system.

Basic warehouse operations:

The basic warehouse operations are composed of movement and control. Movement is the most obvious warehouse function. Warehouse movement is involved only in the short distances (within the warehouse area). The essential operation of an efficient warehousing operation is identified as follows:

Recieve Goods. The warehouse should accept goods delivered from outside and then accept the responsibility for them.

Identify Goods. The appropriate stock-keeping units must be recorded and records made of the number of each item received. It may be necessary to mark the item by the use of a physical code, age, etc. The item may be identified by an item code, a code on the carrier, or container or by physical properties.

Sort Goods. The items may be sorted for the appropriate storage area and shelves.

Apply Location. The goods must be located in a proper space in such a way they may be found easily, whenever needed.

Hold Goods. The goods should be kept in storage under proper protection and conditions until needed.

Recall, Select or Pick Goods. Items ordered by customers must be selected from shelves efficiently and grouped in a manner useful for the next step.

Marshal the Shipment. The several items making up a single shipment have to be brought together and checked for completeness or for explainable omissions, and order records must be prepared or modified as necessary.

Dispatch the Shipment. The consolidated order must be packed suitably and directed to the transportation department if necessary.

Prepare Records and Advice. The number of orders received, items received and items issued must be recorded, as a basis for replenishment action and stock control.[25].

Types of warehousing:

There are two common functional arrangements of warehouses: assembly and distribution warehouses. Assembly warehouses are often used by firms purchasing large quantities of agricultural goods from a large number of sources spread over a wide region. They also may be used by industrial firms which normally purchase a great quantity and wide variety of goods from different suppliers. Distribution warehouses, sometimes referred to as market warehouses, are often used for the mixing and trans-shipment of carload and truckload shipments moving from producing points to large number of customer locations [16].

From the ownership point of view a business firm has three alternatives in regard to warehousing: private ownership, private operation of leased facility, and public warehousing. Leased and owned facilities have a great many characteristics in common and generally have been grouped in the category of private warehousing.

According to the firm's situation and evaluation of advantages and disadvantages of each kind of warehouse, the proper and reasonable one should be selected. It cannot be

said which kind is preferred to others because the kind of warehouse depends upon many factors which usually vary from firm to firm. Each kind of warehouse has different costs and provides different benefits. Before any decision is made, appropriate analysis must be done in order to define which kind of warehouse is preferable to the other. The following are several advantages and disadvantages for each kind of warehouse.

Public Warehouses.

Advantages:

- no capital investment is needed.
- More flexibility: public warehouses allow the company to rent adequate space whenever desired, consequently, firm will be able to react quickly to any variation in market situations or its own policy.
- No maintenance cost.
- No administration cost.
- No management difficulties in handling warehouse activities.

Disadvantages:

- uncertainty. Firm does not have any control over warehouse operations. There is always a possibility that flow of material will stop.
- Limited access. Firm has limited access to inventory. In case of emergency it is very difficult to receive inventory if it is not during working hours.
- Firm has to follow public warehouses regulation rather than its own procedure.

Private Warehouses.

Advantages:

- more certainty.
- More access to inventory.
- More dependent.
- Quick service.

Disadvantages (increase the cost):

- capital investment.
- Administration cost.
- Maintenance cost.
- Depreciation cost.

Warehouse layout and design:

The most commonly accepted principles of warehouse design are: first, use one-story buildings wherever possible because it usually provides more usable space per dollar of investment and frequently is much cheaper to construct. Second, the design and layout should be in such a way that flow of material into and out of the warehouse can be done in a straight line. Third, adequate and appropriate material handling equipment may be used. Fourth, shelves, pallets and totes should be located in such a way as to maximize warehouse operations. If goods are not placed in the warehouse properly this can also create inefficiency. In short, warehouse plans should allow the complete and effective utilization of existing space. Also, appropriate protection systems must be considered in warehouse design and layout [7].

Number of warehouses:

A factor affecting the number of warehouses is the need and policy of the firm for it's customer service. Thus, if the objective is to provide a good service to the customer the number of warehouses should be adequate in order to enable the firm to reduce its lead time as much as possible. Another factor affecting the number of warehouses is the adequacy of transportation facilities. If transportation facilities are inferior, higher inventory levels are needed.

Warehousing costs:

Costs related to warehousing are fixed or variable. Warehousing fixed costs are generally costs of rental or depreciation on building and equipment, insurance, fixed property taxes and maintenance costs. Variable costs are those related to change in quantity of inventories; property tax, warehouse labor and equipment maintenance are some examples. Total cost analysis is essential in the overall evaluation of the efficiency of maintaining a privately operated warehouse versus utilizing the facility and service of a public warehouse. There are many factors which affect the own or rent decision and also affect the location, size and the number of warehouses. Figure II-3 shows transportation costs declining with an increase in the number of warehouses. Warehousing costs increase as the number of warehouses increases. There is more inventory cost as the

number of warehouses increases and finally, the cost of lost sales will decrease when the number of warehouses increases.

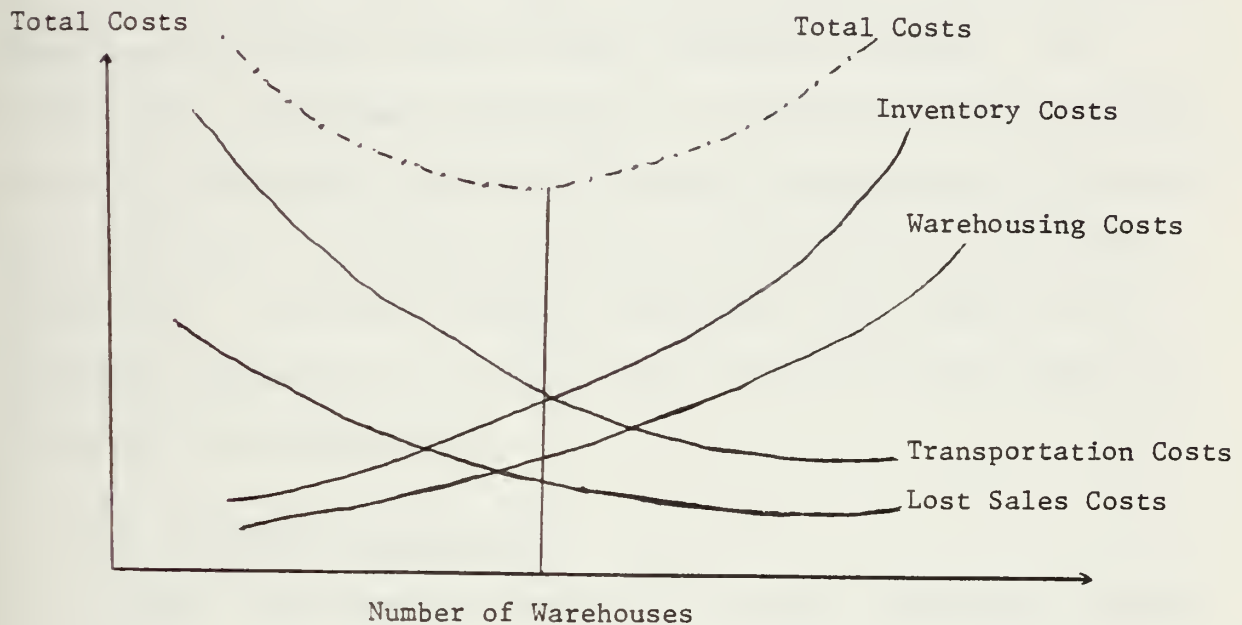


Figure II-3

The influence of warehouse availability on various costs

As indicated in Figure II-3, total cost will generally decline as the number of warehouses increases up to a certain point, then start to increase.

Inventory management:

In past centuries, inventories were considered an indication of wealth. Holding inventories above the amount needed to carry on the process of production was considered

beneficial. A decision on the amount of inventory was made depending upon the firm's financial capability. Factors such as carrying cost, set up cost and capacity of warehouses had less priority. A new warehouse was constructed whenever the old one was completely filled. Many items were stored for many years without even an issue during the period. As technology, management techniques, investment decision-making, economic principles and cost effective analyses were presented and expanded, the inventory policies received more and more attention. In recent decades businesses have shown an increasing awareness of the need for precision in the field of inventory management.[39].

3. Inventory Management

Today, inventories are one of the most important elements of a logistic system. Management of inventories strongly affects the efficiency of the system. Many of the important issues that arise in the design of a logistic system are related to the inventory investment. What inventories should exist? Where should they be located? What differences in inventory locations and levels should exist on the product or production line? Improvement in technology along with progress in the inventory management techniques expand the options in logistic system design. A well organized and properly managed inventory system is essential in any kind of logistics system. Obviously, it is unrealistic to expect all logistic organizations

to have exactly the same inventory management system or to apply the same techniques. However, the same principles apply everywhere.

In this section theory and reason for holding inventory, concept of inventory management and its main objective, basic inventory decisions, inventory costs and different inventory models will be presented.

a. Theory of Inventory

When is a television not a television? In terms of logistics, when it is in New York at the time it is desired in Monterey. When it is black and white instead of the desired color television. When it is 17" in size rather than the desired size. When it is in warehouses at the time it is needed to be displayed in a retail store. When 99.99 percent of its parts are available for manufacture but only one small and minor part is missing [16].

Inventory is concerned with all these problems and it facilitates and provides a possibility that commodities be utilized at the right time, in the desired form and quantities which are needed. Inventories exist in a logistics system because the system can be alive and accurate when it can respond positively to a customer request. It would be either very expensive or impossible to make all requirements available to customers after they are requested or needed, even to use the fastest transportation facilities. One of the reasons

that inventory exists is to save transportation costs, but there are many other reasons which are very important to make it essential that any logistic organization be concerned and careful that adequate inventory levels are carried in the system.

Reasons for Holding Inventories

Inventories must be carried in a logistic system because it takes time to make or move an item. Also, it is not economical to purchase materials or to make and distribute items unit by unit, or even in response to individual customer orders. By using scientific techniques such as probability or statistics principles, the level of demand can be predicted. However, if the confidence interval is even 99 percent there is still a one percent chance for a costly stock-out to occur. Customer demand or material use is not uniform or completely predictable. The rate of customer orders may vary from time to time according to season or the supplier's own marketing effort. There will be substantial random variation in customer's orders for some items from day to day or week to week. Inventories serve and relieve the logistic system from many of the costs and difficulties imposed by customer variation. There are many reasons why inventories are essential and why this huge investment is acquired by all firms or logistic organizations. The most important reasons for holding adequate inventory can be categorized as follows:

- to be responsive to customer demands
- to minimize possibility of stock-out cost
- to decrease transportation cost by ordering carload or truckload rather than less than carload (LCL) or less than truckload (LTL)
- to handle production variation
- to be flexible according to change in plant schedule
- to take advantage of raw material discount price
- to save distribution cost (packaging and material handling)
- protect against strike, and work stoppage
- protect against natural accident
- protect against shortages in raw material production
- to give a desired customer service
- to balance incoming materials against production schedules or sales.

In summary, inventory acts as a buffer between a supplier who usually supplies materials in large amounts and constant intervals and a user (customer or production line) who generally buys the output or uses the material in smaller or more variable quantities.

Concept of Inventory Management

Inventory management can be defined as the sum of all those activities that are necessary for the acquisition, storage, sale, disposal or use of materials. Inventory management is not a new activity, it has been very important in both

private and government sectors for a great many years. Inventory management for all items measures the relative advantage of holding various amounts of different items. When this measurement is defined, appropriate decisions to provide economic equation and balance can be made. Many private and government organizations prefer to choose two or even three different inventory management policies rather than one. ABC theory is an example--Louis M. Killeen indicates:

many managers believe that an ABC analysis is the most rewarding study technique they have ever used [18].

H. Ford Dicky of General Electric Company was one of the people recognized for ranking inventories on the basis of their importance. He used what is generally described as ABC analysis [18]. In short, items were categorized into three groups, the most important was placed in the A group, the next in B and then C. The purpose was not to analyze by different inventory models or theory, but to recognize that inventory management does not handle the different items in the same way.

Objectives of Inventory Management

Inventory managements main objectives can be grouped as follows:

- keep adequate inventory levels
- order the adequate quantities

- utilize available storage space, but prevent stock levels from exceeding space availability
- meet a high percentage of demands without creating excess stock levels (do not run out, do not be overstocked)
- provide an item by item basis, reorder points and order quantities
- decide what items to stock and what items to procure on demand
- recognize the fast moving and slow moving items
- assign priority to supply and demand in case of shortages.

- Basic Inventory Decisions

Inventory decisions are primarily concerned with the questions:

- how much to order or produce at one period
- when to order
- where should inventory be stocked or located
- should a safety level of stock be built up
- if yes, how large should it be
- is it reasonable to have a computerized inventory system [7]?

Inventory situations are basically the same, each involving some aspects of cost, service and usage. The objective in any given situation is to make that set of decisions which will minimize total cost and provide an acceptable or economical level of service at the expected demand or usage rate. Several different models and techniques

have been developed for inventory decision-making, all of these models and techniques deal with inventory planning and control that eventually lead to the above factors. Application of these models does not necessarily mean that the appropriate and accurate decision is made. Thus, except in the most routine situations, a model should never be looked on as a decision maker but rather as an aid to the judgment of the decision maker. It is thus the responsibility of the manager to devise a model that produces useful results at a cost that provides maximum gain. Some of these models and the ways the manager could apply them in inventory decision-making will be described in following sections.

b. Costs

Inventory problems are usually examined from a cost rather than from a profit standpoint. The costs that will result from each specific decision must be determined when deciding how much inventory to carry. The major types of inventory costs are: ordering cost, inventory carrying costs and stock out cost.

Ordering or set up cost:

Ordering or set up costs are composed of all the necessary expenses to place purchase orders, to buy material from a vendor, or to order a manufactured lot from the plant. In order to buy some material it is essential to write the purchase order, to process vendor invoices, to receive

material and deliver to stores or process area. Clearly, costs are incurred. Similarly when a manufactured lot is ordered from the plant some costs such as clerical and paper-work cost, machine setup cost, startup, and scrap cost will be incurred. The sum of the above costs is called ordering or setup cost, the amount of ordering or setup cost for each period remains constant and fixed.

Inventory carrying cost:

The inventory carrying costs include all expenses incurred by the enterprise because of the volume of inventory carried. The amount of this cost usually varies with respect to inventory level (variable cost). Warehousing expenses, insurance expense, taxes, depreciation and obsolescence and opportunity costs constitute the major elements of the inventory carrying cost [7].

Stock out cost:

Stock out cost occurs when a item is demanded by a customer but cannot be filled from the inventory in which it is normally carried. Depending on the item under consideration, stock out cost may include the following:

- in the case of raw material: costs of idled production, cost of placing special order (backorder).
- In the case of finished goods: cost of "ill will" to the enterprise. This occurs when the customer chooses to withdraw his order from the enterprise and turn to other sources because of the inability to deliver or late deliveries by the enterprise (the loss of customers).

- In the case of replacement parts: costs of idle machines, idle labor.

c. Models

Inventory in general is expressed by cost, cost of acquiring inventory, cost of carrying inventory and cost of demand lost either due to holding inventory or to not carrying it. Inventory management is concerned with effective inventory control in order to determine how much inventory to carry; enough so that demand can be met but not so much that the cost of inventory becomes excessive. To achieve these objectives, a set of ordering rules should be developed to indicate when and in what quantity the inventory should be replenished. To develop these rules requires the following actions: (1) to evaluate and select an appropriate inventory model that fits the existing circumstances and (2) to collect necessary data on costs, demand, lead time and market situations that are needed to solve the selected model. Among several inventory models the following are the most popular and are usually applied by different enterprises:

(a) the Economic Order Quantity Model

The Economic Order Quantity (EOQ) model was developed prior to World War I. In this model the objectives are:

- to define the optimum quantity to order. $Q = \sqrt{\frac{2KD}{H}}$
- To determine the number of orders. $N = \frac{D}{Q}$

- To determine the maximum inventory on hand and the average inventory level.

$$\text{Max on hand} = Q \quad \text{Ave. on hand} = Q/2$$

- To define the number of days supply. $d = \frac{365}{N}$

- To define the dollar value of an optimum order and of the average inventory.

$$\text{Opt, (V)} = Q.P \quad \text{Ave, (V)} = \frac{Q.P}{2}$$

- To define the total inventory cost.

$$T_c = T_o = T_H$$

$$T_o = \frac{DK}{Q}, \quad T_H = \frac{HQ}{2}$$

Where Q = the economic order quantity

K = ordering cost in dollars

D = the quantity demand for the period of time

H = carrying cost as a percent of inventory

N = the number of order for the period

d = number of days supply

Opt(V) = value of economic quantity

Ave(V) = value of average inventory

P = unit price

T_c = total cost for the period

T_o = total ordering cost for the period

T_H = total holding cost for the period

The EOQ model assumes a situation where demand, lead time and all relevant costs are known and constant over time.

It is clear that in this situation the replenishment is scheduled in such a way that shipments arrive exactly when the

inventory level reaches zero, therefore, there will never be a shortage. In short, the EOQ model assumes control of inventory under certainty conditions. J. L. Heskett says:

The problem of determining inventory levels would be simple if, say, customers buying items from a manufacturer organized their buying so that they purchased an equal amount of all items every day of the week [16].

Further, it would be easier if the time required to schedule and accomplish production and to replenish stocks of the item was known and constant and if the lead time or ordering and shipping time for raw materials was clear and constant. However, how accurate these assumptions are and how they fit different circumstances is of concern to inventory management.

The EOQ model should be accepted with doubt and suspicion because of unrealistic assumptions. Rarely is there a situation where demands are constant, costs are precise and lead time is fixed. There are always some economic factors and tradeoffs such as price discounts, transportation rate variations, and even ordering costs that eventually encourage modifying the EOQ model. The EOQ assumed a constant lead time for replenishment. However, seldom is it possible to find a situation where ordering and shipping time is exactly met and stable. Variation in production processing and transit time directly affects the lead times. In real life, quantity demands can vary because of change in customer tastes, change in customer income, decrease or increase in customer purchasing

power and many other elements. Uncertainty in price, quantity demands and lead time easily can provide stock out situations if the EOQ model is applied without appropriate modification. Logistics managers, therefore, prefer to keep additional quantities of items to provide a safety level.

(b) The Fixed Quantity (Perpetual) Model.

This model indicates that a constant quantity should be ordered each time the inventory level reaches the pre-determined level (reorder point). The quantity could be defined by application of EOQ formula, in which case a safety stock should usually be added. This model is also called a Q model.

(c) The Fixed Time (Periodic) Model.

This system involves a periodic auditing of the inventory. If at that time the stock of an item is less than the predesignated level an order should be placed in order to increase the inventory level to another predetermined maximum level [7]. The major disadvantages of this system (also called P model) are: a large level of safety stock is required, the non-uniform order size may adversely affect shipping schedules.

There are other inventory models such as the ABC model, two-bin system and so forth. Which model should be applied depends on the firm situation, nature of inventory, economic conditions, capability and capital investment, and the relationship that exists between relevant costs pertaining to organization policy and goals.

P system model is particularly appropriate when the stock level review can be coordinated for a number of items so that inventory maintenance is kept at a minimum. In addition to this, when transportation savings are concerned, the P model can be effective. It is strongly emphasized that models are not solutions. There is no way for the decision maker to avoid analysis of his problem by applying a formula blindly and by chance.

Safety Stock Levels:

In EOQ it has been assumed that the demand and lead time are constant, thus, the inventory can be kept at a level to meet predicted demands. In reality, especially when the enterprises are related to foreign vendors this assumption is not usually accurate. In order to protect stock out an order can be computed and placed so that the delivery will arrive when a certain level of inventory is still remaining. This level of inventory that absorbs unexpected variation in ordering and shipping time is called safety stock. To build up a safety stock which protects shortages in all cases could be very costly. Therefore, management may wish to maintain a safety stock that will protect against a shortage not in all cases but at some desired percentage of the time (e.g., 90%). This means the customer demand must be filled 90% of the time. In other words, safety levels could be defined by the enterprise service level.

$$S_L = 1 - P(S)$$

$$S_L = \text{service level}$$

$$P(S) = \text{probability shortage}$$

When the management defined the desired service level, the appropriate level of safety stock can be computed by the following formula:

$$\text{Safety stock} = Z\sigma$$

Where Z is the number of standard deviations equivalent to the desired service level and σ is the standard deviation of demand during the reorder period. As the safety stock increases the shortage cost reduces and as the safety stock declines the shortage costs increases. In order to determine the best level of safety stock the equilibrium point should be calculated. The equilibrium point is a point at which the shortage cost is equal to safety stock cost.

$$\text{Safety stock cost} = H \cdot Z\sigma$$

$$\text{Shortage cost} = \frac{P(S)(C \times D)}{Q}$$

$$\text{to put } HZ\sigma = \frac{P(S)(C \times D)}{QH}$$

Where:

H = holding cost per unit

C = cost of one shortage

Q = order quantity

D = annual demand

$P(S)$ = probability of shortage (that is equal to 1- the service level)

In those cases where an enterprise seeks a service level higher than can be given when an equilibrium point exists, the best safety level should be computed for several desired service levels and then the lowest selected. Figure II-4 shows cost and equilibrium points.

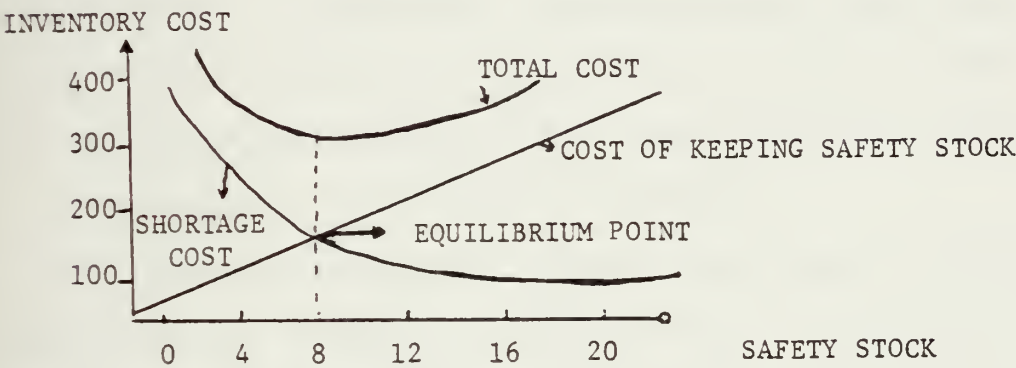


Figure II-4

Graphical establishment of the equilibrium point
and the lowest total cost

4. Transportation Systems

Transportation is another basic element of logistic systems. It cannot be denied that transportation systems have a major role in each logistic activity. Changes in the efficiency of the transportation system are immediately reflected in support program and procurement situations. Therefore, it is essential for logistics managers to have a good knowledge of the major characteristics and elements of an effective and efficient transportation system in order to be able to evaluate the particular significance and relationship of each element to the general situation.

The characteristics of a good transportation system are: responsiveness, flexibility and economy. Transportation is a major part of the broad field of logistic distribution. Men and material must be moved and distributed to plant operational areas, finished goods also must be moved and distributed to the customers.

Bayard O. Wheeler compares transportation to a communication system and indicates:

Transportation is the movement of goods or persons from one place to another. While communication is the transfer of information or ideas, transportation involves the conveying of physical things, while communication takes the form of transmitting thoughts and opinions by speech, writings or signs. Both transportation and communication start with the generation of a pulse comes to rest. Energy may arise from a diesel locomotive in transportation, in communication

from the vibration of two human vocal cords, electric impulses over copper wires, or from radio waves transmitted by an orbiting earth satellite. Transportation and communication differ in the type of service rendered, but they are similar in the creation of place and time utility. The movement of goods and the transfer of information from origin to destination create place utility. Movement or transfer at the time needed generates time utility. Both are provided principally through business enterprise [38].

Communication has been called the nerve system of each organization by many people. It is reasonable to state that transportation is the nerve system of a business logistics system.

Transportation permits the firm to bridge the producer consumer gap and thereby create time and place utility in goods. It is clear that desired goals will not be achieved unless a stable bridge is created between warehouses, plants, customers and material resources. This bridge could exist only if an adequate transportation system is activated. The criteria by which a transportation system can be judged are not identical for all organizations. For instance, in the business world profit and loss are the criteria of judgment. Whereas in the government world, criteria are quite different. The following are some common criteria that can be used in evaluating the operation of a transportation system:

- (1) speed of delivery
- (2) cost of delivery
- (3) flexibility of delivery
- (4) bulk of delivery

Knowledge of the transportation system is fundamental to the efficient and economical operation of the distribution function in business logistics. For this reason, one must recognize some of the basic factors and principles of transportation and also understand frequently used terms such as: transportation system facilities and services, movement control, and traffic management.

- Transportation System Facilities and Services

The transportation system facilities and services are composed of those means and regulations which provide for the carriage of persons or things from one place to another. The system includes vehicles, terminals, pipes, highways, ships, waterways, canals, airways and railroad trackage. The basic modes usually available for business logistics are: railways, roads, waterways, pipelines, and air. The relative importance of each transportation mode and the changes that are occurring in relative importance are partially explained by the composition of freight hauled and the inherent advantages of the mode. For instance, the pipeline is a highly efficient method for moving products in a liquid or gaseous form over long distances. In contrast, air freight is not so much limited in scope by technical feasibility as by the relatively higher rates that must be charged as compared with other modes [1]. Common sense frequently determines which mode is preferred to others, but for a business firm it is not so easy to

decide. There are many factors such as: kind of materials, form of packages, distances, time, and rates which affect the decision making. In other words, it depends upon which mode is more appropriate and more responsive to the firms requirements. To assure maximum profit, transportation selections must be coordinated carefully with other activities in the firm. These usually include warehousing, inventory levels, production planning and location analysis. Transportation systems cover all factors involved in inbound raw material movements and likewise all factors involved in moving finished products from firm to customers (outbound distribution). Usually there are three different legal forms of transportation carriers: common, contract and private.

Common carriers are the backbone of the transportation industry. They accept responsibility for carrying goods anytime, anyplace. Contract carriers on the other hand make themselves available for business on a selective basis. They may charge different rates to different customers for the same service, although they may be required to publish the actual rates which they charge shippers. Private transportation refers to the common ownership of goods transported and the lease or ownership of the equipment in which it is moved. Common and contract carriers are generally grouped into a category which is called "for hire" carriage.

a. Movement Control

In routine supply operations both for physical and distribution supply, good movement control is necessary. It is a fact that traffic matters can be managed effectively only when they are considered as an integral part of the overall logistics system. Henry E. Eccles indicates:

While the principles of priorities and allocations apply to all areas of logistics effort, they are particularly important in transportation. Here the vital link between high command logistical decision and the practical operation of transportation systems lies in movement control[12].

Heskett believes:

Movement control can be defined as the monitoring of a firm's use of transportation facilities with the objective of obtaining optimum use from them. It involves the selection of carrier, documentation of shipments, generation of information about carrier services and rates, measurement of carrier performance, correct payment of carrier charges, and the establishment of measures to be taken when a transportation system does not function as it is supposed to [16].

There is no doubt that effective control of transportation activities requires extensive documentation and a system of information flow that produces data for decision-making and specific checks to provide a comparison of actual performance. The purpose here is to emphasize managerial aspects and implications of movement documentation information.

The basic document of transportation is called bill of lading. This document provides: a contract for the movement of a shipment; a receipt for goods itemized on it; and in

some cases, a certificate of title to the goods. The bill of lading indicates where the shipment originated, where it terminated, the volume shipped and the parties involved at the time of shipment. This document represents a valuable source of data for supply and distribution planning even though it may not contain any information about freight charges. The responsibility for preparing bills of lading typically rests with the shipper. The freight bill is the carrier's invoice for freight charges. Prepaid freight bills are presented by the delivering carrier to consignors for payment. Collect freight bills are paid by consignees. Freight claims are documents providing information about loss or damage to products in transit, unreasonable delay in the movement of freight and freight charges, improperly assessed by a carrier. Claims are prepared by shippers for carrier consideration [16]. Movement control not only could help the transportation manager to decide the following matters but also facilitate the necessary monetary actions to be carried out:

- (a) which material or personnel require transportation
- (b) where the material or personnel must be moved
- (c) at what time such material or personnel must arrive at destination, or along way
- (d) by which type of transportation the material or personnel should be moved?

b. Traffic Management

Most of the traffic manager's responsibilities consist of collecting accurate, up-to-date information about traffic rates, selecting common carriers to be used in transporting material or personnel, preparing claims of overcharge, damage, or loss, and auditing freight bills. He is also expected to follow up lost shipments, supervise the actual handling of freight, and maintain control over back orders. In addition to these routine duties, the traffic manager helps consolidate small orders into carload shipments, arranges systematic warehouse distribution points for less-than-carload lots, studies, and perfects ways of reducing losses in shipments caused by improper packaging and handling of merchandise, and selects the most advantageous or strategic destination points for shipments [7]. Traffic managers should have adequate knowledge and experience in order to decide when to use rail, water, truck or air to transport goods to customers. It also helps to select plant and warehouse sites that will ensure desirable transportation service.

MATERIALS HANDLING

Material handling is quite important to the efficient operation of the warehouse and in transferring goods into and out of the warehouse, and also in moving goods to various storage points in the warehouse. Since the handling can either be performed by elaborate mechanical equipment or performed by manual labor or both, it is most convenient to think of materials handling as a short distance

movement which usually takes place within the confines of a building such as a plant or a warehouse [7].

These activities that supplement the primary warehousing activities of the firm affect the overall efficiency of distribution system operation. Material handling such as any other art or science, has its own principles which must be considered. The principles that apply most widely are:

- (1) handling cost must be reduced to minimum possible amount.
- (2) Handling must be eliminated wherever possible, and where it is necessary, the work should be done by mechanical means, not by hand.
- (3) Handling methods should be correlated with operations, inspections, storage and other handling that comes before or afterward.
- (4) Handling routine must be made as nearly automatic as possible so that the costs are minimum.
- (5) All handling systems should be integrated in order to obtain greater efficiency.

Material handling considerations are an integral part of the storage space decision. If the choice is public warehousing, compatibility of the firm's material handling system with that of the public warehouse is a prime consideration. If a company operates under the use of private warehousing policy, the efficiency of the entire materials handling operation is concern.

The objectives of material handling are:

- (1) increase space utilization. One of the basic objectives of any material handling

is to increase the useable capacity of the warehouse facility. In order to reduce the warehousing cost it is quite important to utilize the storage spaces as much as possible.

- (2) Improve operating efficiency. Another objective of material handling is to reduce the amount or the number of times goods are handled, an efficient design of a material handling system could minimize the number of movements that take place.
- (3) Effective working conditions. All material handling systems give some consideration to safety. The system should be so designed that the possibility of danger to people who are working around the area is minimized.
- (4) Improve customer service. Handling as an activity center in logistics, plays an important role in improving efficiency by making the logistics system respond to its customers requests quickly and effectively.

5. Packaging

Packaging, as another important element of logistics, will affect the operation of warehouses. Packaging is also quite important for effective damage protection. As the size of the package may affect the ability of a company to use pallets or shelving or different types of materials handling equipment, some consideration should be given to the package characteristics. Coordination should exist between packages, handling equipment, warehouse spaces and transportation facilities. Packaging not only facilitates handling, transportation, protection and accessibility, but it also affects the marketing and customer service. Packaging improves the efficiency in

handling and distributing, it provides essential protection to goods and facilitates identification of products.

6. Customer Service

In general, the two major elements that affect the customers decision with respect to choosing a commodity in a free market are the price of the commodity and the level of customer service that he or she could receive if the item is purchased. In other words, in much the same way that customers respond to price in selecting products, they respond to the level of customer service. The higher the quality of customer service provided, the greater will be the revenue received from any given group of customers. Customer service is the end result of logistics system design and operation. Customers are generally more sensitive to service rather than price, thus, variation in service provided may cause a lower sale revenue. Customer service that impacts all areas of the firm attempts to ensure customer satisfaction by the provision of aid or assistance to that customer. The following are various factors that logistics customer service could provide to the customer:

- (1) shorter lead time. Lead time (time elapse from the period that a customer places an order until physical receipt of the order) has a direct affect upon the level of inventory that a customer should keep until the next order is received. As the lead time decreases the customer could carry lower inventory levels and consequently lower the corresponding inventory carrying cost. Thus, a seller can

lower a buyer's cost by reducing lead time and at the same time increase the desirability of his product in the free market.

- (2) Dependability of lead time. When a lead time is applied for some specific commodity the seller must try to maintain the predefined lead time in order to give adequate confidence to the customers who usually adjust their inventory to a minimum level if the lead time is fixed. Dependability of lead time has direct impact upon the customer's inventory level and stock out costs. It also can reduce the uncertainty faced by a customer. Dependability refers to the delivery of a customer's order with regular, consistent lead time, in safe condition and in harmony with the type and quality of items ordered.
- (3) Communication. Customer communication is essential to the design of a good logistics service. By communicating with the customer, it is much easier to modify the existing customer service. It may be hard or even impossible for logistics managers to sit down at the office and decide how to justify the customer service.

Providing a good logistic customer service may incur more cost. The service level should not be sacrificed in order to reduce logistics cost, but logistics managers must balance the customer service level, total logistics cost and total benefits to the firm. As has been previously described, customer service may impact all areas within a firm. However, the author is primarily concerned with customer logistics service. A study by Hutchinson and Stolle identified seven such factors of interest to the logistics manager:

- (1) order processing time: elapsed time from receipt of the customer's order until it is ready for assembly.

- (2) Order assembly time: time required to prepare the order for shipment.
- (3) Delivery time: time in transit to the customer.
- (4) Inventory reliability: stockouts, back order, percentage of demand filled, omission rate, percentage of order completed and so on.
- (5) Order size constraint: minimum order size and allowable order frequency.
- (6) Consolidation allowed: ability to consolidate items from several locations into a single shipment.
- (7) Consistency: range of variation occurring in each of the previous elements [7].

They also noted some factors not under the direct control of the logistician, and group them into the following categories:

- (1) frequency of salesman's visit to check on his client's needs.
- (2) Order convenience.
- (3) Order progress information.
- (4) Inventory back up during promotion.
- (5) Invoice format and organization [7].

From the above study it is apparent that logistics does not have direct control over all elements of customer service. However, through logistics and the customer service elements relevant to the creation of time and place utility in goods, the logistics manager is able to have direct control over the customer service variable for which he is held responsible. Logistics managers must ensure that adequate coordination in the establishment and performance of customer service with other departments is made.

G. TOOLS OF LOGISTICS

There are several tools and management techniques that a logistics manager must be familiar with if he is expected to successfully accomplish his mission. The major logistics tools which will be presented in this section are: organization, planning, execution and supervision and control.

Organization

Richard H. Hall indicates:

An organization is a collectivity with a relatively identifiable boundary, a normative order, ranks of authority, communication systems, and membership-coordinating systems. This collectivity exists on a relatively continuous basis in an environment and engages in activities that are usually related to a goal or a set of goals [22].

The term organization has two distinct interrelated meanings. One interpretation views organization as an identifiable entity or structure. A second interpretation relates organization to a process of arranging or structuring the parts of an organization in such a systematic fashion that functional activities are grouped and authority relationships are ascertained and formulized [22]. Examining organizing as a process shows why organizational structures vary from firm to firm and from industry to industry. The process of organizing organizational structures is merely a tool or technique for achieving the firm's goals.

While the concept of organizing appears rather ambiguous, fundamental logic can be applied to the task of organizing.

Seven sequential steps that usually are involved in organizing are:

- (1) overall goals must be identified and established.
- (2) Objectives, policies and plans must be developed.
- (3) Activities essential to achieving objectives, policies, and plans must be discovered.
- (4) Activities must be classified.
- (5) Functional activities must be grouped relative to the availability of resources and optimum techniques of employment.
- (6) Each group leader must be given sufficient authority to enable him to perform his task.
- (7) Groupings must be unified both horizontally and vertically through information systems and authority relationships [19].

In addition to the above factors the following question must be evaluated and answered in order to define the essential boundary and scopes of the logistics organization. The first question to be examined is complex: is there a definite need for a distinct and separate logistics department? If yes, where should the activity be located within the firm? The second question concerns line and staff controversies: If a logistics department is to be established, should it occupy a line position or should the department be assigned to a staff position? Third and last the question of centralizing or decentralizing the function must be resolved.

Planning

Planning is the selection of goals and defining of policies and procedures for achieving them. Logistics planning is a management tool for confronting the future by making present decisions. Logistics planning represents managements attempt to anticipate the future and guard itself against the threat of change. The purpose of logistics planning is not to show how precisely the future can be predicted but rather to uncover the things that must be done today in order to have a future. Today more logistics planning is required because of more complex technology, narrower specifications, longer lead times, larger investments, greater uncertainty and larger size. Generally there are three different levels of planning:

- (1) strategic planning that deals with long range consideration (five to ten years), it looks at the overall goals (what market and what product).
- (2) Tactical planning that is concerned with medium-term (budget, staffing plans and etc.).
- (3) Operational planning, that is related to current operations (inventory level, annual cost).

Plans are predetermined courses of action that presents organizational goals and activities. Plans are generally made to solve problems but if they are unattainable, they could create bigger problems. A logistics planner must be aware of all possible changes in strategic and tactical plans in order to be able to prepare premodified plans (contingency plan:

procedure for alternative courses of action). As J. O. Vance indicates:

Time is the greatest enemy of all strategy and planning the moment a plan is drafted, it starts to become outdated. A plan is always based upon an estimate of future developments drawn from past trends and present conditions [37].

Since these conditions are always changing, the logistics plans should be continually modified. The factors that logistic planners should consider are not constant and permanent. To be most effective, planning factors should be based on the detailed study and evaluation of many types of situations. Planning factors do not become good planning tools unless the planner knows the circumstances under which the fundamental usage data on which the factors are based were collected and proposed. The process of logistics planning is facilitated when the answer to all the following questions can be made available to the planner [10].

- (1) What is the problem?
- (2) What are the facts relating to the problem?
- (3) What recent information is available in addition to the facts?
- (4) What are the assumptions?

Execution and Supervision

In order to achieve the logistics goals, first the defined plans should be interpreted to detail action and converted to sequence steps that must be taken at a definite time (programming). The predetermined programs must be executed

regarding the related milestones. How well the logistics plans and programs can be implemented largely depends on how realistic and feasible they are. Usually planning and programing are very simple to create, but they are not so easily executed. If the people who plan or program logistics activities are not aware of actual execution processes, or they plan behind closed doors without necessary coordination they will never achieve the logistic goals. To ensure the programs are correctly carried out or modified (when necessary) the organization must supervise the execution of the programs. Supervision of the programmed actions involves a very close relationship between the planner and executives, and requires a high degree of experience. The amount of supervision required during execution depends on the category in which experience indicates the individual is most frequently found [10]. Good programs reduce but do not eliminate the need for supervision during execution.

Control

Logistics plans and programs may be made and implemented, but that alone does not ensure accomplishment of the goals around which the plans and programs were developed. In addition to organizing, planning and executing, it is essential to think in terms of a fourth basic aspect. The fourth aspect is control. Control may be defined as the process where planned performance is brought into line or kept in line with

desired objectives [10]. In the logistics system the manager seeks to control planned logistics activities (transportation, warehousing, inventories, materials handling, etc.) in terms of customer service and activity cost. Control systems for logistics programs range from highly formalized and elegant mechanical systems to systems that are kept under control by personnel who have a good feel for business. In either case an effective logistics control system could exist if adequate, accurate, relevant, and timely information about activity or function performance are received by the control system and then necessary evaluation is carried out. The steps in control are as follows:

- (1) defining the level of performance for each logistics program
- (2) measuring actual performance
- (3) reporting the actual performance to appropriate people
- (4) comparing actual performance with specific program if:
 - (a) performance is in control, no action is necessary
 - (b) performance is out of control, corrective action must be taken
 - (c) performance less than expect, but effort seems satisfactory, validity of the specific program must be investigated and essential modification be carried out.

Conclusion

In this chapter it was concluded that the concept of the logistic system and technology of logistics have made substantial

advances in many countries. Today, logistics is a word that sounds scientific. Elements of logistics are: forecasting, procurement, storage, transportation, material handling, packaging and customer service. Forecasting that eventually determines the overall requirements is the basic element of logistic planning. Make or buy are two different ways of procurement. Which is preferable is the job of management to define. After adequate analysis is done, inventory that acts as a buffer between a supplier and a user forms one of the most important elements of a logistics system. Relevant costs involved in inventory management are, ordering or set up cost, carrying cost and stock out cost. Transportation systems facilitate time and place utility of goods. Transportation, facilities, number of warehouses and level of inventory are closely related to each other. The tools of logistics that logistics managers must be familiar with are: organization, planning, execution and control.

III. CHARACTERISTICS OF AN EFFECTIVE AND EFFICIENT LOGISTICS SYSTEM

It is neither possible nor practical to formulate and provide an ideal logistic model which can be applicable to any logistic system. In reality the configuration and functions of a logistic system may vary for different factors and circumstances. However, there are some general principles and characteristics which have a great impact on efficiency and effectiveness of any given logistic system.

An improved understanding of these theories and principles together with experience and ingenuity are necessary to increase efficiency. In this chapter static principles of a good organization, basic functions of a logistics system, different forms of a logistic organization and logistics information system will be presented and argued.

A. STATIC PRINCIPLES OF A GOOD ORGANIZATION

There is no doubt that different kinds of organizations require different structures but there are several static principles that can be applied in any kind of organization. If these principles are ignored within the organization the output of the whole system will be affected and eventually efficiency and effectiveness of the organization will be reduced. The following are brief definitions of these principles.

1. Chain of Command

This principle indicates all individuals from the bottom to the top should have a superior to whom they are accountable.

2. Unity of Command

Each person in the chain of command should have one and only one direct superior to whom he or she is accountable.

Harry Levinson indicates:

This principle of command unity is widely violated for several reasons. In a small family-owned business, middle-level personnel sometimes receive instructions from several members of the family, who are unable to establish clear-cut authority relationships at the top [20].

3. Span of Control

Span of control means each superior is able to effectively control several subordinates in the job he or she is responsible for. In other words, span of control is a number which measures how many people report directly to a common superior. Grant M. Davis has presented a mechanistic formula to compute the number of people who can be controlled by a superior. The formula are:

$$\text{Span of management} = \frac{A_t - (b_t + c_t)}{a_t}$$

Where A_t = Available time for a superior

a_t = Average dependency of each subordinate to the superior

b_t = Interdependency of subordinates activities (coordination)

c_t = Interrelationships of the work units to other organizational units [8].

The above formula may be applied to compute the number of the people who should be controlled by a superior if the elements of the formula (b_t , c_t , a_t) are properly defined. The real problem is how to calculate b_t , c_t and a_t . Experienced managers and organization simulation may provide better organizations than all artificial formula for span of control.

4. Clarity of Delegation

Whenever a manager gives some part of his authority to one (or more) of his subordinates the degree of initiative he expects the subordinate to take must be clarified. Harvey Sherman indicates:

Misunderstanding of a manager's authority appears to be widespread. Fifty percent of the time a first-line supervisor and his superior disagreed on the former's authority. There are either substantial over-estimation or underestimation of the subordinate's authority and the subordinates seldom demand clarification [34].

He also indicates that in order to prevent misunderstanding the superior should clarify which of the following action(s) is (are) expected from the subordinate.

- a. Look into the problem Give me all the facts, I will decide what to do.
- b. Let me know the alternatives available with the pros and cons of each. I will decide which to select.

- c. Recommend a course of action for my approval.
- d. Let me know what you intended to do. Delay action until I approve.
- e. Let me know what you intend to do. Do it unless I say not to.
- f. Take action. Let me know how it turns out.
- g. Take action. Communicate with me only if your action is unsuccessful.
- h. Take action. No further communication with me is necessary [34].

5. Completeness of Delegation

For each activity within the organization there must be someone who is responsible and also every person must know he or she is accountable for some specific activity.

6. Sufficiency of Delegation

Authority should equal responsibility. In other words, each person in the organization should have authority sufficient to perform the task for which he is being held accountable. Sometimes neither superiors nor subordinates delegate or accept authority.

- a. Some superiors do not delegate because (1) they may believe subordinates will not be able to perform the activity as well as they can, and therefore their superiors will be displeased with the results. (2) Fear that the subordinates do a better job thus threatening their security. (3) They want to keep some activities secret. (4) They like to see the results of the action in a quicker way.
- b. Some subordinates refuse to accept delegation because (1) they do not like their superiors. (2) Do not want to be bothered. (3) Fear of

disability and performance. (4) They believe it does not affect their payoff [4]

7. Non-Delegatable Responsibility

This principle indicates a manager can delegate authority but not responsibility. The author believes if a manager will be punished for every subordinates mistake, he will delegate nothing and if a manager will not be accountable at all he prefers to delegate all responsibility he has. Neither cases are practical. A manager is always responsible for what is happening in his areas, actually he has overall responsibility anyhow.

B. BASIC FUNCTION OF A LOGISTICS SYSTEM

Any particular organizational structure which manages the logistics activities should have the capability to perform several functions, chief among these functions are: system administration, activity and function coordination, system planning and design and policy determination.

1. System Administration

A group of unarranged warehouses, handling equipment and transportation facilities or a group of unorganized people do not make a going concern. Someone must decided how these facilities should be utilized; who is to do each part of the work and settle a wide range of other problems. Administrator of a business logistics is too broad and complex for one individual to handle entirely on his own. Administrative

problems may be involved in policy, organization resources and operations. It provides a framework for thinking about the overall management of the system. Administration system is appropriate both as a tool of analysis and as an aid in understanding the interrelationships between the various problems. Logistics administration system as any other administration system must:

- a. determine policies and objectives which will focus and guide the activities of the logistics system. These plans help the employees to recognize the purpose and direction of the work and limitation within which action is to be taken.
- b. Set up an organization to carry out the objectives and policies.
- c. Assemble resources needed to implement the plans and provide them to proper section..
- d. Provide procedures, methods and schedules needed for specific operation and ensure that they are satisfactorily applied by the employees.

2. Activity and Function Coordinated Within the Logistics

The basic issue in logistics organization is how to achieve coordination or cooperation among various activities and functions so that logistical plans can be implemented effectively. In order to provide an item available to a customer in a specific time, and desired location, someone must predict it in advance; someone must procure it; someone must keep it; and someone must transfer it to the ultimate consumer. In the process of these activities if even one of

the actions are not carried out as scheduled, the final result will be affected and consequently, the item needed will not be received by the customer in the proper time. Thus, in order to increase efficiency and effectiveness within the logistic system it is essential that all logistic activities which must be carried out by different departments and people be primarily coordinated.

3. Activity and Function Coordinated Within the Enterprise

Coordination and cooperation in a logistic system are not limited within the logistics organization itself (internal coordination). There are several functions that must be coordinated with other components of the firm (external coordination). These external divisions are: marketing, manufacturing, production and finance.

a. Marketing

Marketing policy and tactics have a fundamental effect on the design and operation of the logistics system. The wider the sales level, the more complex and large the distribution system. Physical distribution should be able to meet the marketing requirement, thus, logistics plans and activities that are related to physical distribution must be coordinated with marketing in order to be able to distribute the finished goods to the market place (customer).

b. Manufacturing

The manufacturing function interacts with the logistic system in two ways, (1) logistics should be able to

respond to the demand of the physical supply (provide adequate raw material and components to the plant). (2) Logistics systems must be able to transfer the finished goods to the ultimate customer (physical distribution). Any decision making with respect to inventory policy and distribution facilities would be affected by manufacturing magnitude and requirement. The more manufacturing plants the more demands there will be for raw material. Thus, in order to create proper harmony among the above activities, logistic and manufacturing should coordinate their plans and activities and have a very close cooperation with each other.

c. Production

In a well-run, modern company, the management policies concerning inventories, customer service and plant hiring and lay-off are developed rationally from information supplied by the production control function [32].

Inventory policy as it was described in Chapter II depends upon many factors including production. There is no doubt that production decision simply affects the inventory policy and plan. The wider the specially ordered products, the more complex the prediction and supply of inventories. However, if the logistic system is expected to respond to the production requirement properly, it will be essential for logistic managers to be aware of production schedules and changes in order to coordinate the logistics plans with production policy and changes.

d. Finance

Financial management is naturally concerned with the efficient use of the firm's capital. The design and operation of the logistic system requires many trade-offs between commitment of capital, reduction of operating costs and improvement of delivery service. These conflicts can be reconciled by a policy with respect to the value or availability of capital in the logistic system. This policy is often expressed in the form of a capital cost or required return on capital investment [25]. A well-designed logistic system makes a major direct contribution to the financial control of the firm. Logistics ties up the firm's capital by incurring inventory cost, to construct new warehouses, to purchase transportation facilities and other requirements. If appropriate coordination is not carried out with financial management in advance, the logistic plans may not be implementable. So, in order to ensure that the logistic plans can be supported concerning capital investment, logistic managers must coordinate the logistic's plans and capital requirement with the firm's financial manager.

4. System Planning and Design

Another function of a logistic organization is to make provisions for planning and replanning. Logistics decisions are influenced not only by internal environment but by changes in external environment also. Changes in market situations,

supply and demand, competitive positions and fluctuations in prices are some elements of external environment. Change in any of these factors may directly affect the logistics plan and decision-making. In other words, planning and replanning in a logistic organization can be concerned as a function of its environment changes. As the environments are dynamic and change continuously, in order to enable logistics organizations to react promptly to any kind of changes, the system planning and replanning for logistic activities and operations should also be a continuing activity.

5. Policy Determination

A logistic policy is a general plan of action that serves as a guide in the operation of the logistic system. All the logistics policies such as: procurement policies, inventory policies, transportation policies, warehousing policies and so forth make up the basic framework for management decisions which set the course the logistic system is to follow. Policies are vital to effective administration of a logistic system for a number of reasons.

- a. With policies that are clearly understood, a busy logistic manager can delegate duties to subordinates with confidence that these duties will be carried out along the general lines he or she wishes.
- b. Policies enable the manager to know how others will act and result in making the coordination easier.
- c. Policies as accepted guides give adequate confidence to subordinates to make

decisions and act according to responsibility they have. This eventually creates more initiative within the organization.

The logistics policies that should be coordinated with other departmental policies (sales, production, personnel and finance) must be directed toward the enterprise's basic policies also. The following are some broad groups of logistics policy classifications:

a. Procurement policies

- (1) When should the requirement be made and in which situation must they be purchased?
- (2) If the requirements should be purchased, which method of purchasing should apply?

b. Inventory policy

- (1) Which model or techniques should be applied in order to determine the level of inventories?
- (2) Should the safety level be carried, if yes, at which level?

c. Warehouse policies

- (1) Which kind of warehouses will be utilized (private, public)?
- (2) What kind of equipment should be used in warehouses?

d. Transportation policies

- (1) In what condition should the requirements be delivered, by air, water or by rail?
- (2) How often the transportation mode should be utilized.
- (3) Should the enterprise provide private transportation facilities?

C. LOGISTICS ORGANIZATION FORMS AND GUIDELINES

Logistic organization is the structure that facilitates the creation, the implementation and the evaluation of plans. It is a formal or informal mechanism for allocating the human resources of the firm to achieve the firm's goals . An organization structure should clearly define the operating task and delineate the responsibilities associated with each task. It should be understood that a good organization structure does not produce good performance by itself, however, a poor organization structure makes good performance difficult. The most important factor that directly affects the level of performance is the capability of the personnel who operate within the organization. There are different alternatives open to top management when considering how to organize for logistics management. In this section the discussion is focussed on different possible organizations for logistics activities.

1. Line Organization

The line organization presents the oldest and the simplest type of organization pattern. In the line organization the authority relationships between the line managers and subordinates have three attributes.

- a. The line manager has total authority.
- b. Each line manager has direct authority over his subordinates.

- c. Subordinates report to only one immediate supervisor and likewise, receive orders from only one.

A line organization has some advantages such as simplicity, speed and discipline, but is most often applied only in the very small enterprises that have a limited number of employees. Line organization structure makes it difficult to perform analyses that are required for effective logistics systems to be carried out. This kind of analyses usually must be done by logistic managers who are capable of both administering day-to-day operations as well as analyzing, planning and designing logistics activities. Thus, people who work in line organization and are capable to respond to day-to-day activities may not be capable for analyzing, planning and designing the logistics activities or even if they are capable they may not have adequate time to perform both tasks.

2. Staff

As was indicated, line personnel usually are involved in day-to-day operations and have little time for undertaking major analysis to improve logistics performance. Thus, especially in large organization, some other people are required who can plan and define the basic activities and also ensure performance and provide them adequate advice whenever needed. The people who accomplish these kinds of tasks are called staff people.

3. Line and Staff Organization

The structuring of a logistic organization on the

basis of pure line or staff activities solely creates some problems. The line type of organization is rather inflexible and does not provide for task specialization by managers. In contrast staff personnel facilitate the work of the line by acting as designers, analysts and advisors. Therefore, they do not have authority to make decisions or give orders (except in their own departments). Depending upon the characteristics of the enterprise the appropriate solution is to combine the line and staff activities into one department so that the staff and line personnel can accomplish their task by close cooperation and adequate coordination. As a general guideline in establishing a logistic department the line function should not be created unless supported by a competent staff function [3].

4. Centralized and Decentralized Organization

Centralization is not like a disease that a doctor can indicate either someone has or does not have. In other words, it is not possible to state that one logistic system is completely centralized and another is completely decentralized. Rather logistic organizations are relatively centralized in some functions and relatively decentralized in others. In fact, perfect centralization and perfect decentralization are both impossible and every organization must adjust to an intermediate system. The extent to which a logistic system can be centralized depends on its situation, size, technology, managerial capacities and environment position. The repetitive,

routine and simple tasks, especially in a stable environment, are best handled through formal, centralized organizational structures; the complex and creative tasks, especially in an unstable environment, are best handled through informal, decentralized structures. In general, answers to the following questions may help determine the extent to which centralization or decentralization will be effective.

- a. Who knows the facts upon which decisions will be based?
- b. Who can get the information most readily?
- c. Who has the ability and knowledge to make sound decisions?
- d. Must speedy decisions be made to meet local conditions?
- e. Must local decisions be carefully coordinated with other activities; or are local units fairly independent?
- f. How busy are top level executives?
- g. Will initiative and morale be improved by decentralization; will this help the organization? [40]

Both centralized and decentralized organizations have their own merit and should contribute several advantages if they are applied in a proper way. In other words, as James and Herbert indicate:

There is no theoretical advantage to either centralization or decentralization; it depends on those deceptively, simple terms "knowledgeable and wise" [27].

What they have tried to indicate is that both centralized and decentralized methods can improve the outcome of the system if the selected method fits the organization size, situation and environment. At the same time they can easily harm the organization if the selected method is inappropriate for the situation and environment position. The increasing complexity and sophistication of modern products and services have caused logistics organizations to become more heterogeneous and differentiated among various specialities. Where these tasks can be simplified and routinized in a stable environment, the centralized system may suffice. Where logistics activities and tasks are not unique, unpredictable and creative, more flexible organization processes are needed to unite authority and knowledge in such a way that the decisions can be made by the most knowledgeable individuals or groups. In short, it is sound to conclude that logistics activities should be organized and aligned in such a manner that fits the task being performed, the technology being used, the individuals, and the environment confronted. Indeed no organization structure is sacrosanct.

D. LOGISTIC INFORMATION SYSTEM

A Logistic Information System (LIS) is oriented around the provision of information to users in support of decision-making. Such systems may employ a number of models which are used to produce meaningful information in a form usable by

decision-makers. Advances in information technology over the past years have led to a wide variety of computer based management information system for supporting different levels of management decision-making. Progress made in the computer area is very important and helpful to managers because it aids in making decisions with more certainty. This does not necessarily mean that LIS has to be based on computer systems, a clearly defined manual system which provides right information, in the appropriate time can help the manager in decision-making also. In this section, definition and characteristics of LIS, elements of LIS computer, and LIS and function of LIS will be described.

1. Definition and Characteristics of LIS

There are many definitions of what a Logistic Information System is; however, most definitions have basically similar components but with varying degrees of explicitness. The purpose of all these definitions is simply to identify exactly what LIS is intended to accomplish. In other words, the definitions help to clarify the purpose of Logistic Information Systems.

What is the purpose of LIS? Just exactly what does management really want to obtain from utilization of an LIS? In one word, it is information, and one step further, it is the right information presented at the right time. But the word information is very misleading. It can mean different things to different individuals. Some people confuse data

with information and some individuals believe that the more data or information available to the manager, the better the decision he reaches must be.

Peter Schoderbek clearly distinguishes between data and information. He indicates:

data is an accumulation of facts and materials which are to be used inferentially but have not been evaluated as to their worth to a specified individual in a particular situation [33].

In his view, information is:

inferentially intended material evaluated for a particular problem for a specified individual, at a specific time, and for the explicit purpose of achieving a definite goal [33].

The purpose of LIS is to provide management at all levels with all relevant information in the most easily assimilated form, at the precise moment when a decision has to be taken regarding the logistics areas. The general characteristics of LIS is to, provide the accurate information at the right time. Logistic Information System is the nerve center of logistics. It is the means by which the money, manpower, materials, machines and facilities are molded together so that they can function as an integrated whole. It performs this integrative role by:

- a. providing information to the various branches of the organization and indicating the impact their individual actions have on the whole.

b. Establishing sensors and control measures for data acquisition required by all segments of the logistics organization.

c. Maintaining central data banks that can be utilized in the decision-making process.

d. Generating output information on demand and on an exception basis that reflects the operation of all segments of the logistics organization, including the Logistic Information System.

2. Elements of LIS

What are the elements used to perform the above integrative role and how are they used to accomplish their function? Murdick and Ross identify the elements as procedures, equipment, information and people [30].

a. Procedures

Procedures are the detailed and formal instructions for operating the system. They assign duties and responsibilities and identify the tasks to be performed. They should be flexible enough to provide for easy assimilation of new systems that may be required as a result of changes and problems that may arise. Procedures include such things as input-output documentation, program flowcharts, computer programs (in computerized systems) and instructions for operating the system after it is installed [30].

b. Equipment

Equipment in a computerized LIS means, of course, the computer and its related equipment. Today there are third generation computers with enormous and (in relation) to previous computer generations) inexpensive storage capacities, increased operating speeds measured in nano-seconds, in a manual system, equipment means all office machinery of facilities that are required to keep the LIS operational.

c. Information

Information as Henry C. Lucas, indicates:

we define information as a tangible or intangible entity which serves to reduce uncertainty about some future state of event [24].

He also indicates each kind of information has the following characteristics:

- (1) time frame (historical-predictive)
- (2) expectation (surprise-anticipation)
- (3) sources (external-internal)
- (4) scope (summary-detailed)
- (5) frequency (high-low)
- (6) organization (structure-loose)
- (7) accuracy (high-low)

The author believes information is the cornerstone, the single most important element of any LIS. As indicated earlier, the system should provide information rather than data, that is, evaluated material that is applicable and will aid in the decision-making process. In order

to identify and design an efficient LIS, the relevant information must be distinguished from the irrelevant. The information needs of each executive must be determined. This requires a thorough understanding of the role, responsibilities, authority, and relationships of each potential system user. In defining information requirements, it is seldom effective to ask openly the executive what information he requires, because in many situations he really won't know or he may confine his requirements to standard reports and the traditional inventory data so often used. This narrow view of what constitutes information available in a logistic information system excludes information about the future, information expressed in noninventory terms such as market situation, adequacy of customer service, and information about the environment in which the logistic must survive.

Martino indicates:

decision-making requires a bilateral flow of information. Information flows to the manager triggering a decision. The decision, which in itself represents information, becomes flow from the manager to the rest of the organizational structure [28].

So it is quite clear that in addition to initial decision-making, information is needed to know what happened as a result of the decision made. In Martino's words:

we need immediate feedback in the form of measurement against a standard and against meaningful summaries of real data. (We do not want to be smothered

with number). We want knowledge and information in the real time of its occurrence or, in other words, in the appropriate time frame of the action [28].

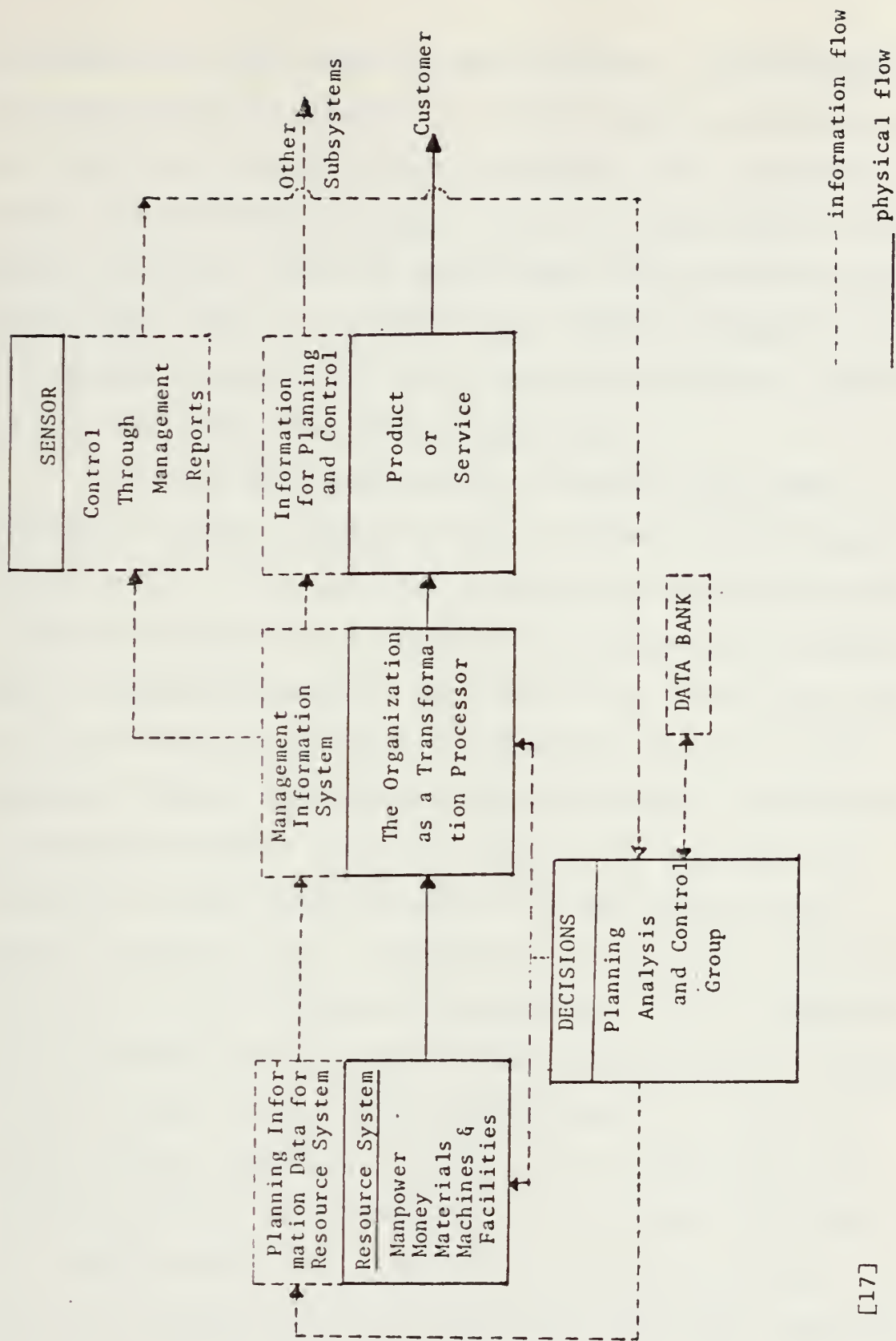
What is expressed by Martino is that an effective logistic information system requires a feedback and control mechanism as part of information flow. If the desired output of the system should deviate from the established standard, the LIS should have the capability of sensing the malfunction and of taking the necessary action to adjust the inputs to correct the deficiency.

d. People

People are the least predictable, the least subject to control and, of course, one of the most important elements of the logistic information system. The people involved in LIS are those who operate the system and manager-users of the system. The important aspect of people in LIS is that the manager-user must be intimately involved in the design of the system and cannot abdicate that responsibility to the people who operate the system. On the other hand, the operators must take it upon themselves to learn more about the functions of management and, thus, acquire a better understanding of the manager's information requirements. Figure III-1 presents a clear diagram of a possible information system as described in this section.

3. LIS and Computers

It cannot be denied that computers as a very important



phenomenon are very fast and very accurate. Unfortunately they are also very expensive. On some highly repetitious jobs, its speed and accuracy allows a computer to do the work at a lower cost than human beings. Due to the high cost of computers, however, this only occurs when the work must be repeated many times. In other words, computers should be used for economic reasons, not for increasing the firm's reputation or just for going along with competitors.

As with many technologies, computers have been purchased by some countries without adequate analysis and consideration. If a physical existence of computers within a firm or country can be viewed as an indication of development or industrialization, the firm or the country may have at least some psychological satisfaction that can justify its expense. This is not necessarily advantageous. Utilization of computers without adequate analysis not only does not necessarily mean industrialization or modernization but simply increases costs. Consuming the national resources in order to be called modernized enterprise or to be imagined as an industrialized country without giving adequate consideration to basic facts and ultimate payoff, is a way of wasting scarce resources. It is a way of exhausting the economic strength of the country. It is a way that never ends with benefits and it is a way that eventually transfers the national resources to other countries without any technology

advancement. Thus, as much as computers can increase the speed of the processes and eventually the speed of the outputs, it may increase the cost.

Utilization of computers within the LIS system creates both advantages and problems. The following are general advantages and problems of a Computerized Logistic Information System (CLIS).

a. Advantages from Proper Utilization of CLIS

The advantages obtained by a computer-based logistic information system are almost all a direct result of the coming of the computer and its capabilities of extremely fast manipulation of vast amounts of data and tremendous information storage capacity.

Timeliness is considered by many as the most important advantage gained by CLIS. Krauss indicates:

if we were limited to choosing the
single most important reason for
information systems, we would have to
name time [17].

The computer's capability of quickly performing routine clerical functions, manipulating, consolidating, summarizing and even evaluating a great deal of data, and capability of preparing routine reports, has freed the manager and his subordinates from these time consuming tasks. As a result, the organization which is using a CLIS not only will be able to reduce personnel costs to perform these tasks, but also will free the manager so that his time can be spent

on appropriate managerial functions. More up-to-date information will be generated by a computer which can help the organization research and evaluate as well as provide more time for management to study the situation, thus making it possible for him to render faster decisions.

Another advantage also tied to application of the computer, is the opportunity for more comprehensive analysis. With the CLIS, the manager is no longer forced to "go along" with the one recommendation his subordinates were able to develop in the time allowed. Now he can demand and expect several alternatives to be presented for consideration.

Simulation is another benefit of the CLIS.

William F. Boore believes:

Simulations are in essence trial runs of how things might be done. They invoke models or representations which are more or less "like real situations" [2].

Possible solutions to a problem can be tested on the computer in simulated, realistic situations and then the manager can see in advance the results that would probably occur if he applied a given solution to the problem. Simulation is considered by many as one of the major contributions of a CLIS.

The following is a summary of the advantages of a CLIS if the computer has been utilized effectively [2].

- (1) Render faster decisions
 - a. Detect and authenticate opportunity
 - b. Identify and isolate problems

- c. Define and analyze situations
- d. Evaluate and appraise alternative course of action
- (2) Accomplish more in the available time
 - a. Think more deeply about the situation
 - b. Ponder other variables
 - c. Gauge and contemplate ramifications
 - d. Investigate more alternatives
- (3) Make more thorough analysis
 - a. Review more meaningful information
 - b. Obtain a better collection of relevant viewpoints
 - c. Used advanced management techniques; that is, methods of industrial operations research
 - d. Simulate more conditions
 - e. Ask and examine more questions, particularly the "what if" type.

When the system is integrated in such a way that all the necessary information is available to all of the organization and individual branches and it is not needed to perform duplicative data collection and maintenance function, it can be accepted that the CLIS has been utilized properly.

b. Problems Involved

- (1) System structured around the computer rather than around computer needs.

One of the most important facts is that CLIS must be designed and implemented according to the needs of the user

of the system. Unfortunately, this fact is too often overlooked or forgotten during the pressures of the system development. Too many organizations have purchased the computer first and asked questions later on how the system should be developed and what needs it should be designed to fulfill. John R. Gale points out that:

Many companies rushed to obtain the new generation computer equipment, justifying the cost with vague notions of the potential services it would provide [14].

Others have not made the mistake of buying the computer first and justifying the need for it later, but have built the logistic information system around the computer's capabilities instead of around the needs of the users. Often this situation is a result of management's mistake of allowing the computer technician to set the goals for the information system. The technician is understandably machine-oriented, not user-oriented. His interests will be in developing a system. Gale says, "geared to maximum computer operating efficiency rather than to the usefulness of its output." He also indicates:

An information system constructed around the users' needs is the only practical approach. To build a system around the computer configuration or the data processing technicians' ideals produces a mechanically efficient product, but it may generate information that is superfluous to management decision, control, and planning functions. While there is ample room for both user-oriented information systems and mechanically efficient

data processing operations, senior management must assume the responsibility of defining system development, and technicians should design the program to achieve management's information goals [14].

(2) Incomplete identification of needs.

Another common failure in computer-based logistic information system design is the incomplete identification of user needs. Sometimes the logistic managers know that the problems of the logistic system are hidden somewhere in the print, but he cannot find them.

Managers believe that the problems are created because the computer technicians don't give them the information they need. On the other hand, the computer technician puts the blame on the managers, insisting that they do not know what information they need. This sort of disagreement occurs usually when the computer technician or system design expert is not attuned enough to the management function to be aware of the total ingredients in the decision-making environment, or on the other hand, management is not actually aware of the limitations of the computer.

In order to avoid the problem of incomplete identification of user needs, the more successful organizations suggest that thorough need identification is a joint management/systems design responsibility. Some firms have teams consisting of management and systems design representatives working out the problem together. According to Anton K. Dekom,

another alternative is a properly conducted survey in which it can be defined:

what data the company has, what data is needed, and what is the volume of data to be handled by the system. Further, it will indicate when information is generated, when it is needed, who causes decision, who creates data, who needs it, and how the computer can be used [9].

(3) Incorrect Priorities

Frequently in the development of CLIS the priority assigned a project or module will be based on the power of the position held by the individual who will use the information, rather than on the importance of the project to the firm.

Daniel Couger discusses the importance of identifying the correct project priority. He gives some guidance on which systems should be identified as the principal user systems and given the higher priority. He says,

unfortunately, priority designations among systems are often inconsistent with criticality of the system to the firm's operations. Too frequently accounting systems are given higher priority than systems which provide greater return on investment, such as an inventory system, or than systems which initiate company actions such as the market forecasting system [5].

A priority system, approved by top management, will help to reduce the frequency of unwarranted "crash programs" that are pressed ahead of more vital requirements.

(4) Failure of Communication

There are two areas of concern in the "failure to

communicate" problems. The first area involves the inability of the user and systems analysis to communicate. The second area involves top management's inability to communicate to logistic personnel the importance of the successful implementation of CLIS.

The analyst must become more aware of the management function, and better understand the decision-makers information needs. The users should become more aware of the computer's limitations.

In the second area involving communication of the importance of the logistic information system project to the logistic personnel, it is important to remember that resistance to change and lack of a feeling of participation can prevent the success of the project. Martino argues that:

Upper management knows that these benefits will be achieved, or it would not proceed with an information system. Tell the employees. They would like to know, too. It is obvious that their support is needed to bring these benefits to the company. Without such employee support, the LIS installation and the new system will be in for trouble. Therefore, it is important to start the educational program when the first study of the system begins [28].

The development of a new logistic information system can generate fear and uncertainty. The new system will most likely result in organizational changes, new procedures and reduction of routine clerical jobs. Such a situation will naturally make employees unhappy about their future, and can easily

create resistance to the new system. To avoid such a problem, the importance of the system to the firm, and therefore to employees, must be effectively explained and perceived.

(5) Top Management Involvement

Top level management attention is necessary to the successful implementation of a CLIS.

Above all, there must be managerial attention. A survey made by McKinsey and Company states that,

no company achieved above-average results without the active participation of top management [28].

Usually a top logistics manager feels that its support is all that is required and he delegates the responsibility for the development of the CLIS to subordinates or the systems design technicians; but support alone is not enough.. The experience and knowledge of top management are very important to determine the degree of requirements of the system.

(6) Underestimating

The designing and implementation of a CLIS are extremely complex and difficult. It may take one to three years to design and implement. Sometimes the complexity of the system is underestimated and users expect faster results and they become impatient for output. Another danger is underestimating the system's complexity is that it can often result in inadequate project staffing.

The most effective way to prevent this problem is to develop a comprehensive statement of the new logistic

information systems capabilities with time tables showing the scheduled development stages expected. Krauss says: "The key to success is to have a series of planned implementation phases that have payoffs at shorter time intervals." [17]

4. Function of LIS

Data obtained from different sources are not usually in an appropriate form for decision-making or not available when and where they are required. In order to improve those deficiency logistic information systems should be able to provide proper information for logistics decision-making. The basic functions of logistic information system ensures the manager that adequate informations will be available where and when they are needed in order to facilitate decision-making. The basic functions of LIS may be categorized as follows:

a. General Functions

- (1) Transferring data into a more useful form (relevant informations).
- (2) Storing the informations until they are needed.
- (3) Transferring informations to points in the logistics network, where they are required.

b. Managerial Functions

- (1) Order processing.
- (2) Systems control and monitoring.
- (3) Internal communications.

E. CONCLUSION

Regardless of those factors and circumstances that cause the configuration and structure of a logistic system to vary, there are some general principles and characteristics which have a great impact on efficiency and effectiveness of any given logistics system. These principles are:

1. Chain of command
2. Unity of command
3. Span of control
4. Clarity of delegation
5. Completeness of delegation
6. Sufficiency of delegation
7. Non-delegatable responsibilities

System administration, function coordination, system planning and design and policy determination are basic functions of a logistics system.

It is concluded that the form of a logistics organization depends on many factors such as: size, managerial capacities, culture technology and environment. Thus, it is a poor policy to assume that because a logistics organization form is quite good and appropriate for one enterprise within a country it is also appropriate form for similar firms in other countries. Nor should one assume that if a logistics organization form is proper for one firm it can also be proper for other enterprises within the same country.

From investigation in this chapter, it is concluded that: logistic information systems provide relevant information in appropriate time for managerial decision-making. Also, the LIS is increasingly becoming a mandatory tool for survival.

It is concluded that many problems have indeed been encountered in development of a CLIS. In spite of this and high cost the use of a CLIS should be encouraged.

IV. PROPOSED LOGISTICS SYSTEM

Chapter II of this thesis is devoted to an analysis of the general subject and elements of business logistics systems. In Chapter III, the major factors and characteristics which are key elements in improving the logistic system's efficiency and effectiveness are considered.

In this chapter the author intends to propose a conceptual logistic system for Iranian enterprises. If it does not resolve the problems and difficulties of the existing logistic support system, it can at least, be considered as an opening to a more effective and efficient logistic system. In the process of this thesis it has been intended to present those facts that may eventually convince top managers and impress them with the importance of logistics in an enterprise.

A. OBJECTIVE

Logistic systems exist solely to provide responsive support to customers. The customers may be production plants, departments or individuals within the firm or ultimate consumers in the market place. Regardless of the organizational structure and strategy within a firm or industry, every logistic system should be designed to help achieve a number of objectives, namely:

1. to improve service
2. to reduce investment

3. better production stability
4. greater utilization of resources
5. to maximize the economic value of products or materials by getting and having them; where they are wanted at the time they are needed and at a reasonable cost. In other words, minimize the total cost in the maximization of time and place utility in goods.

B. STRUCTURE OF THE SYSTEM

In order to design a proper structure for logistic systems it is essential to find out where in the organization the logistics function should be placed. Placing logistics under marketing would result in increased customer service, warehouses and inventories and limited attention to production requirements. If located in an existing transportation department, emphasis would be placed upon rates, carrier negotiations, etc., which are important elements in logistics but not ends in themselves. Likewise, if incorporated into production, difficulty could arise in administering the needs of marketing, since primary attention would likely be directed toward production with logistics serving as a supporting element to production. The need to establish a logistics department in a high position on a par with marketing and production may not be necessary for all firms. However, it is advisable in those enterprises which are involved with a vast amount of logistics activities, and efficiency and effectiveness of the outputs and final benefits are severely

related to logistics functions. Obviously, for effective operations, the logistics structure should be placed in a high position, reporting directly to either the president or an executive vice president. Such a position enables logistics managers to accomplish the decision-making in an objective manner and with sufficient posture that decisions will be implemented with the authority vested in the corporate hierarchy. The proposed structure (Fig. IV-1) is based on this assumption that a separate logistic system should be designed.

The essential building blocks of the proposed system as shown in Figure IV-1 are: policy and system design, a material department, research and development, administrative services, procurement department, warehousing department and transportation department.

C. FUNCTION OF THE SYSTEM

The organization which manages the logistic system must perform several functions and ensure that these functions are performed. In the proposed system each department has been designed in such a way that all these functions may be carried out separately and with adequate coordination. There is no doubt that where the enterprise situation and size permits, several of these functions could be performed by one department.

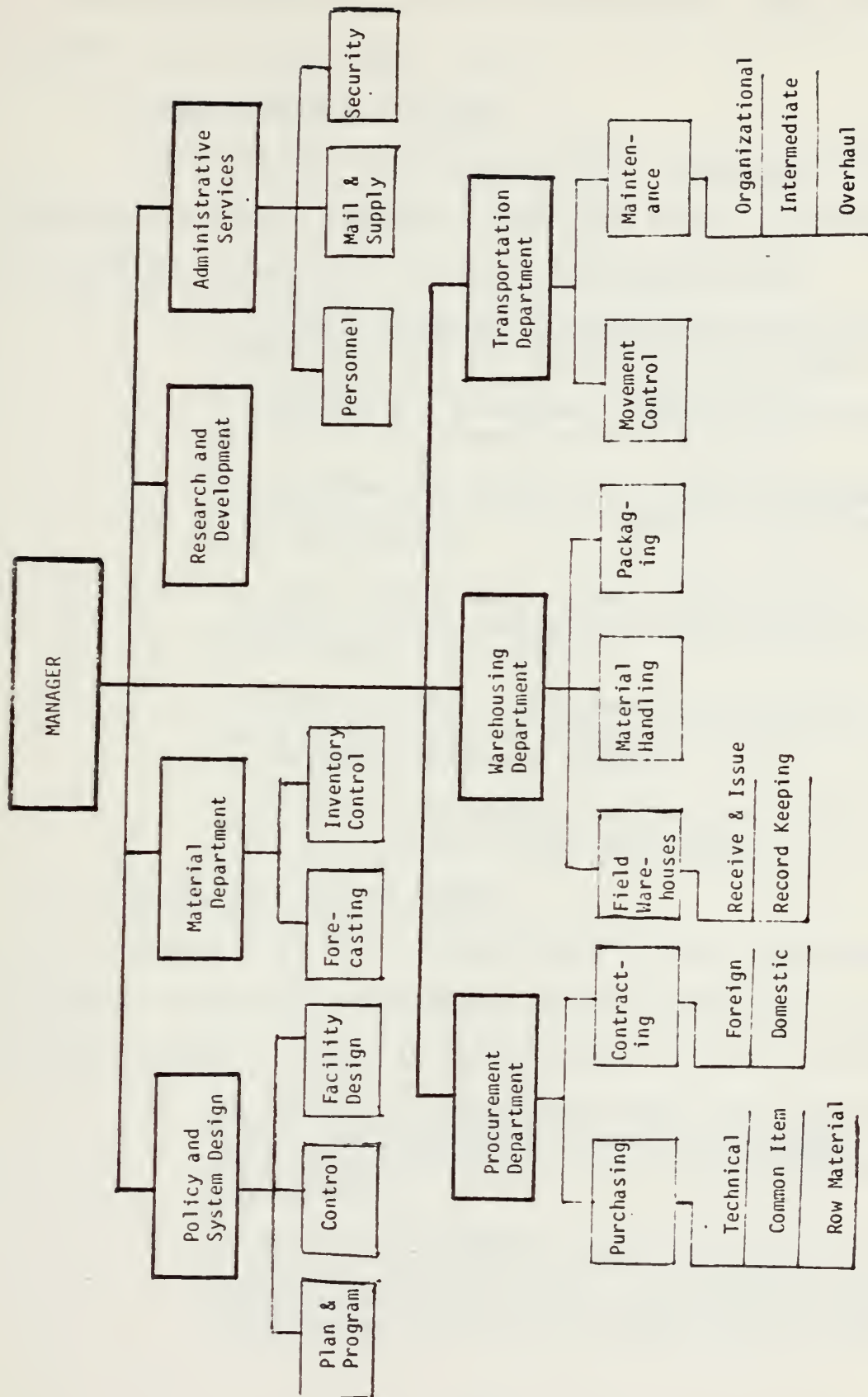


FIGURE IV-1

A Conceptual Logistics Organization for Iranian Enterprise

Following are descriptions of the various functional elements depicted in Figure IV-1.

1. Administrative Services

Administrative services would be comprised of three separate sections: personnel, mail and supply, and security. It would be responsible for the following actions:

- a. to employ adequate personnel with necessary specialization for different departments
- b. to handle all personnel administration such as vacation, promotion and rotation
- c. to receive all letters and correspondence and deliver them to the expected department and vice versa
- d. to take proper actions and ensure that security of the logistics warehouses and departments are adequate
- e. to request office equipment and stationary from warehouses and support logistics departments whenever needed.
- f. coordinate all administrative plans with plan and system design department.

2. Policy and System Design

Policy and system design would contain three separate sections: plans and programing, control and monitoring, and facility design. Responsibilities would include the following:

- a. to define both long and short run logistics plans and programs for the whole system with close coordination between different departments
- b. to provide and define logistics policy for different functions such as inventory policy, customer service policy, procurement policy, warehousing policy and transportation policy

- c. to ensure that the defined plans and programs are successfully implemented
- d. to modify and change the plans and program whenever needed
- e. to take appropriate actions for resolving the problems that may affect the plans or programs to be implemented with regards to the defined milestones
- f. to analyze all alternatives that exist for every new logistics decision regarding facilities requirements such as: new equipment, warehouse location, etc., and to recommend the best courses of action.

3. Material Department

Material department would have two different sections: forecasting, and inventory control, and would be responsible for the following functions:

- a. to receive all plans and programs from planning
- b. to receive sales forecasting from production or marketing
- c. to accumulate all departmental requirements
- d. to define logistics requirements for the specified period (Fig IV-2)
- e. to provide financial and procurement departments with a copy of logistics requirements (forecasts)
- f. to modify the forecast requirements according to any changes that occur in sales programs or other plans and inform the procurement and financial department
- g. to define inventory levels and ordering methods with regard to inventory policy

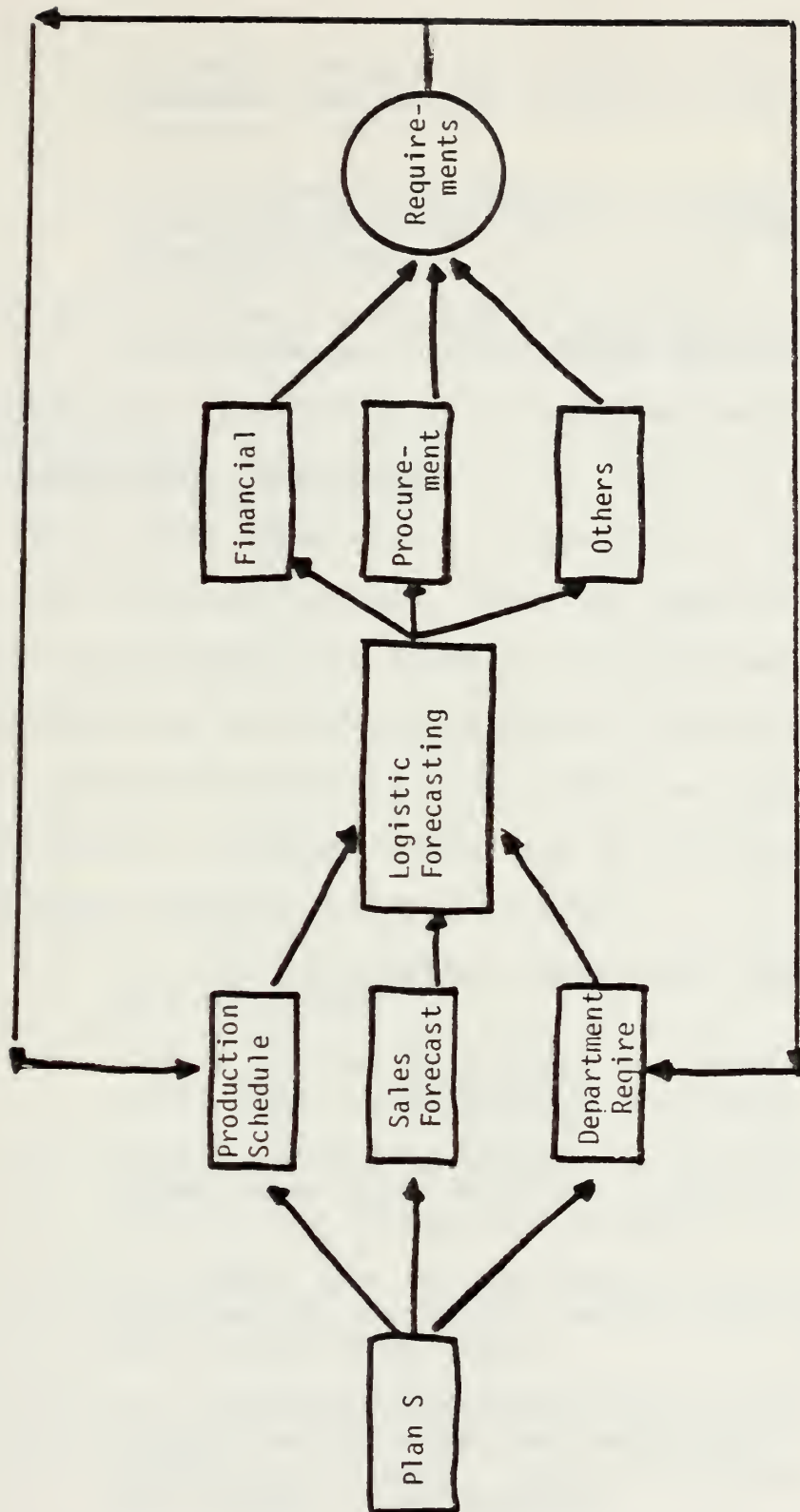


FIGURE IV-2
A Conceptual Logistics Organization for Iranian Enterprise

- h. to define safety level policy with adequate analysis in respect to the inventory costs
- i. to do appropriate analysis to reduce inventory cost with regard to customer service policy
- j. coordinate all material management plans with plans and system design department.

Figure IV-3 shows the process of an order or requisition.

4. Procurement Department

Procurement department is composed of a contract section and purchasing section. When the logistics forecasting or special requirements are received by procurement, adequate analysis should be carried out in order to define which items should be purchased and which items should be made. The following are the different steps that may be followed by procurement after adequate analysis is made:

- a. to inform production those items which are to be made
- b. inform contracting section to purchase those items that should be purchased
- c. inform purchasing section to purchase those items that should be purchased quickly and without any contract
- d. to ensure that the requirements are provided in the right quantity, the right quality and right time
- e. to inform material department if any change must be taken in quality or quantity of items. Figure IV-4 shows the process of procurement
- f. coordinate all procurement plans with plans and system design department.

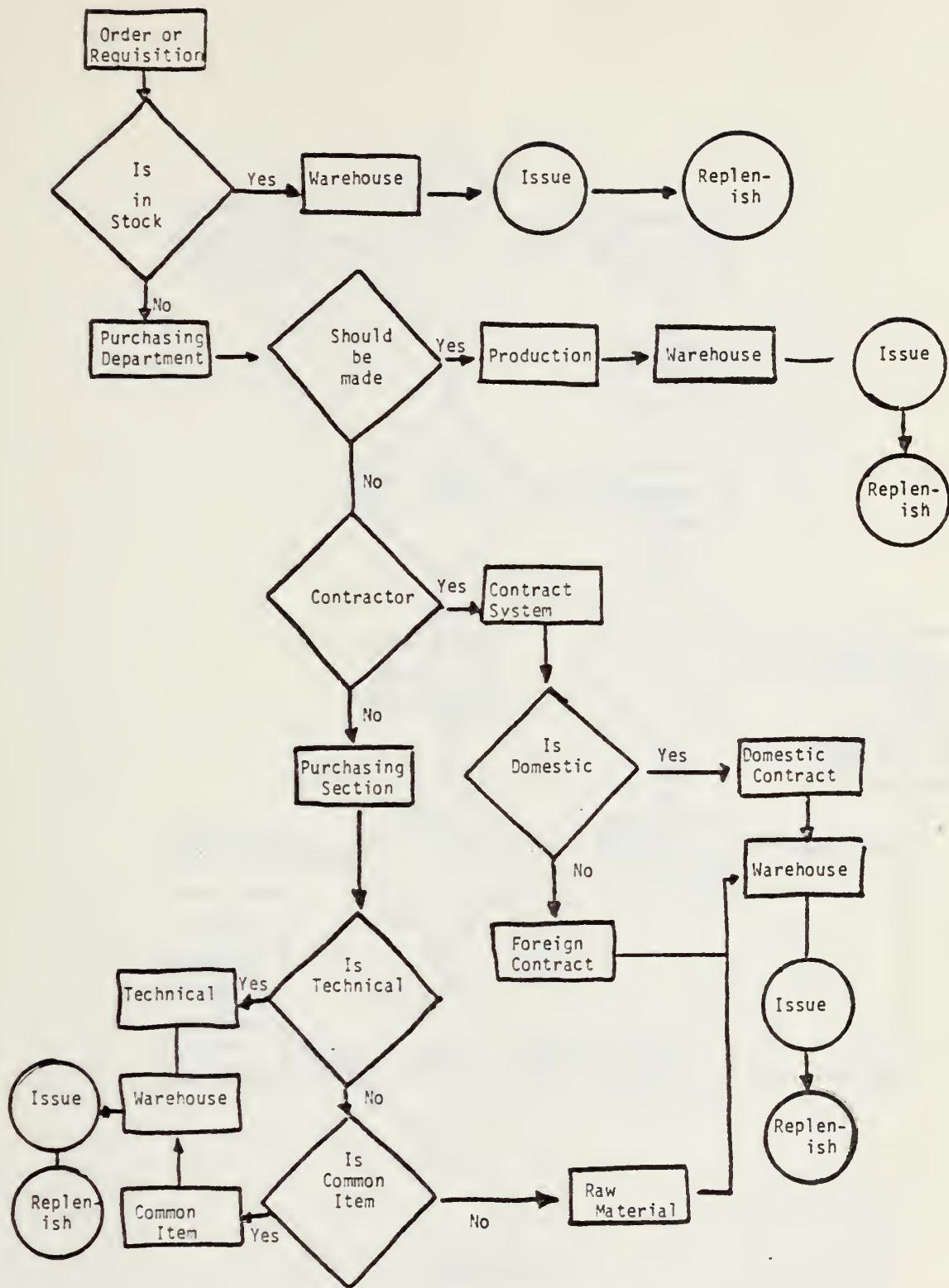


FIGURE IV-3
Flow Chart for an Order or Requisition

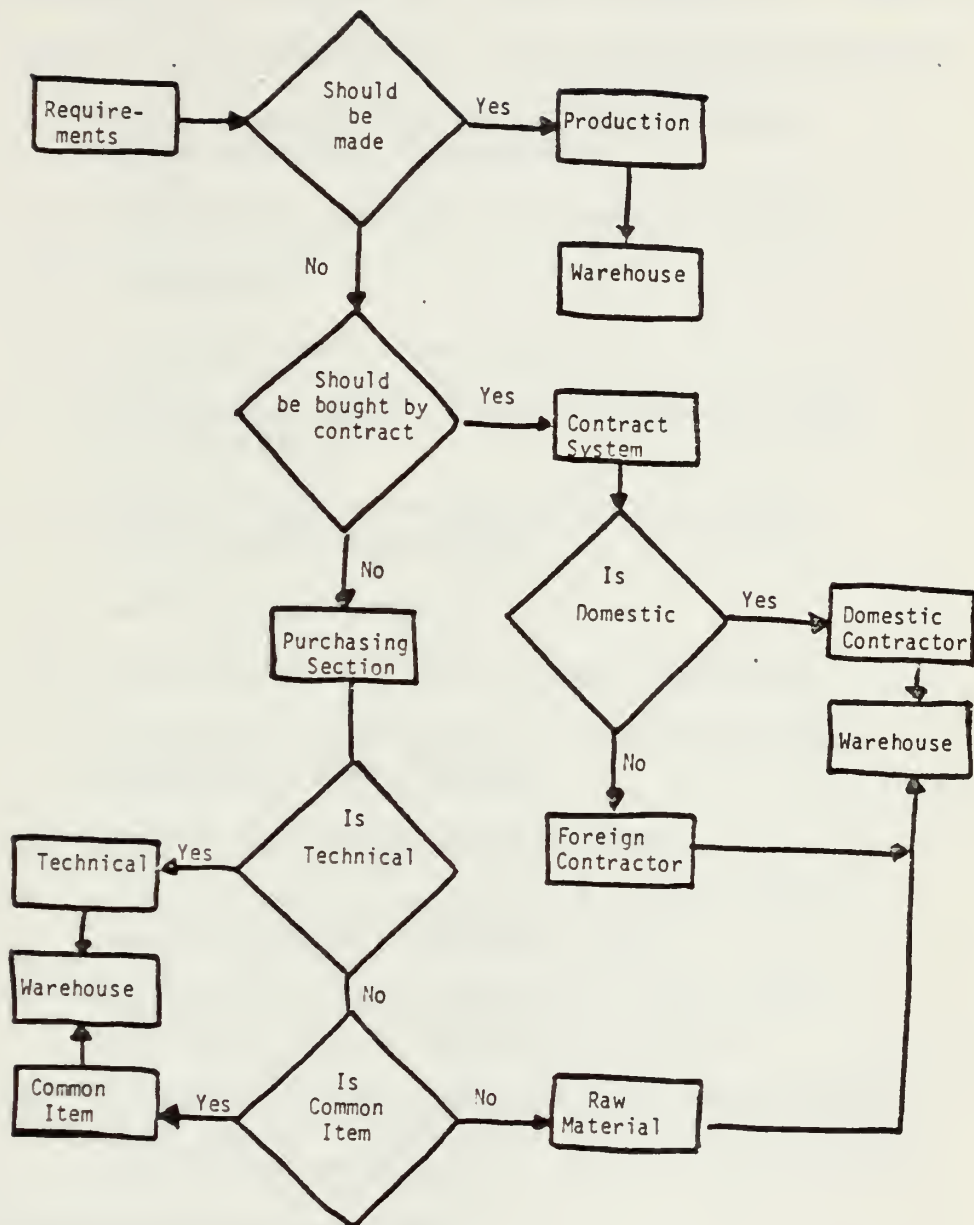


FIGURE IV-4
Flow Chart of the Procurement Process

5. Warehousing Department

The proposed warehouse department is composed of material handling, packaging and field warehouses. This department would be responsible for the following functions:

- a. receive goods delivered from outside after adequate inspection
- b. record the quantity of items received
- c. sort goods
- d. allocate each item received
- e. hold goods under proper protection and coordination
- f. recall, select or pick goods that are requested by customers
- g. marshal the shipment
- h. pack the consolidated order properly
- i. deliver all packages to transportation department for shipment
- j. update the stock record cards
- k. request proper handling equipment and ensure they are properly used
- l. coordinate all warehousing plans with plan and system design department
- m. cooperate with transportation department with regard to material handling equipment repairs or service.

6. Transportation Department

This department with two sections, movement control and maintenance, would be responsible for the following actions:

- a. selection of carrier
- b. documentation of shipments
- c. generate information about carrier services and rates
- d. measurement of carrier performance
- e. which material or personnel must be moved
- f. where the material or personnel must be moved
- g. at what time such material or personnel must arrive at destination or along the way
- h. by which type of transportation the material or personnel should be moved
- i. prepare claims of overcharge, damage or loss and audit freight bills
- j. repair the firm's transportation facilities and handle the repair facility. Usually transportation facilities require three different levels of repair. The first level that may be called "organizational repair" can be done by the person who is the driver of the car such as weekly engine oil or battery inspection and so forth. The second level of repair that may be called "intermediate repair" is composed of regular services and short time repairs. The final level that may be called "overhaul" is concerned with major repairs such as overhauling the engine or painting the body.
- k. coordinate all transportation plans with plan and system design department.

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